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THE NICARAGUA CANAL COMMISSION will sail from New York for Greytown, Nicaragua, on Dec. 5 by the U. S. steamer "Newport." The Commission will be accompanied by a corps of about 60 engineers and surveyors, which, upon reaching Nicaragua, will be divided into several parties for carrying on the field work. This field work will include topographical and hydrographic surveys, borings along and adjacent to the line of the canal, river gagings, observation of the rainfall and generally the collection of all data necessary for the study of the problem. The duration of the work cannot now be determined, but the Commission states that a thorough and exhaustive study of all the conditions will be made. The Commission is composed of Rear-Admiral John G. Walker, U. S. N., President; Col. Peter C. Haines, Corps of Engineers, U. S. A., and Prof. L. M. Haupt.

THE PITTSBURG-OHIO SHIP CANAL REPORT of the engineers is now printed and is ready to be laid before the proper committees of the next Congress. Congress will be asked to provide one-half of the $33,800,000 required, payable in alternate installments of $1,000 after an incorporated company has first actually expended $1,000,000 upon the work. A similar bill was introduced into the last Congress, but it died in the committee room.

THE PORT ARTHUR TRANS-ATLANTIC STEAMSHIP Co. has been organized in Kansas City, to operate a line of steamships to be run in connection with the Kansas City, Pittsburg & Gulf Ry. Co. The first steamer is expected to sail on Dec. 24, and will carry passengers and freight, touching at Liverpool and then proceeding to Hamburg, and touching at Rotterdam on the return. Until the ship canal from Port Arthur to Sabine Pass is completed the steamers must be loaded from lighters on Sabine Lake. The tonnage of the vessels to be used will range from 2,500 to 5,000, and they will sail every two weeks.

THE DAM ACROSS THE RIO GRANDE RIVER near Las Vegas, N. M., for which a contract was let some time ago by the Rio Grande Dam & Irrigation Co., is to be the subject of further litigation. A temporary injunction against the construction of the dam was dissolved in July, 1897, by the U. S. Circuit Court for New Mexico. It is now reported that the U. S. Department of Justice will appeal from the decision. It is claimed that Mexico would have just cause for complaint against the United States for allowing the dam to be built and water diverted from the stream for irrigation that would otherwise flow into Mexico; also that the control of the river is vested in Congress. The court named decided that the above contentions were baseless. The works, actual and proposed, of the Rio Grande Dam & Irrigation Co., were described in our issue of July 15, 1897. Mr. J. L. Campbell, of El Paso, Tex., is Chief Engineer of the company.

THE 42D ST. DISTRIBUTING RESERVOIR, on Fifth Ave., New York city, has been officially declared as no longer useful in the distributing of water in that city, the large mains having been extended far below it. It may now be removed at any time and the space, 436 ft. square, or about four acres in extent, which it occupies, will be added to Bryant Park and will form the site of the new New York Public Library. This reservoir was the terminus of the original Croton Aqueduct, completed in 1842; and James B. Jervis was its Chief Engineer with Horatio Allen as his Principal Assistant Engineer. This reservoir, on Murray Hill, was built entirely above ground, with hollow walls ranging in height from 36 to 40 ft. above the ground. With a maximum of 36 ft. of water its capacity was 24,000,000 U. S. gallons. The exterior wall is uniformly 4 ft. thick, with a batter of 12 on 2; the inner wall is vertical, with offsets, and is 6, 5 and 4 ft. thick. The space between these two walls is 14 ft. wide at a point 41 ft. below the top, and 9 ft. 9 in. at the springing line of the brick arches near the top. There are frequent cross-walls between the two outer walls, pierced by 6 × 1½ ft. openings, permitting inspection all around the reservoir and serving as a drain for any water leaking through the inner wall. Inside of the masonry walls is a thoroughly puddled earthen embankment, with a base of 58 ft. and a slope of 1 on 1½ for 24 ft. high, and 1 on 1 for 16 ft., making, with the walls, a top width of 17 ft. The bottom is an impervious hard pan, and on this was placed 2 ft. of puddled earth and 12 ins. of hydraulic concrete. The reservoir is divided into two divisions by a water-tight wall of masonry, at the toe of which is a sloping bank of puddled earth, 18 ft. high, covered with rubble masonry. This embankment is 19 ft. thick at the bottom and 4 ft. wide at the top. With 36 ft. of water the water surface was 115 ft. above tide mark, and the reservoir is three miles from the City Hall. Water first passed from the reservoir into the pipe system on July 2, 1842.

THE OHIO STATE WATER-WORKS ASSOCIATION is the latest proposed organization devoted to water-works interests. Mr. C. W. Wiles, Superintendent of the Delaware Water Co., Delaware, O., is now canvassing the superintendents of the State to ascertain their feelings in the matter.

THE VALIDITY OF THE HYDRANT RENTAL CONtract between the city of Danville, Ill., and the Danville Water Co., made on Nov. 9, 1882, for a term of 30 years, has been upheld by the State Supreme Court of Illinois. In 1895 the city passed an ordinance lowering the hydrant rental agreed on in the contract, basing its action on a legislative act of 1891 authorizing cities to regulate the prices charged for water within their limits. The company sued to recover the difference between the new ordinance and the old contract rate and secured judgment in the circuit court of Vermilion Co., which judgment is now affirmed by the Supreme Court. The city maintained that the old hydrant rate was unreasonable; that the new statute put the matter of price in its control; and that it exceeded its authority in contracting for water for 30 years, alleging that the contract conflicted with some constitutional provision regarding the debt limit of municipalities. The courts simply held the contract to be valid and binding for the full term of 30 years. We are indebted to Mr. Owen T. Smith, Superintendent of the Freeport Water Co., Freeport, Ill., for a copy of the above decision. The Freeport "Journal" states that an exactly similar case is in the local court regarding hydrant rentals in that city.

MUNICIPAL GAS WORKS AT VIENNA are now under construction, according to a recent consular report. The city is now supplied by a private company under a contract that will expire in 1899. Negotiations for the purchase of the existing works by the city were unsuccessful. The company has been charging about $1 per 1,000 cu. ft. for gas furnished private parties and the public buildings and about 80 cts. for street lighting.

TESTS OF 5,427 GAS METERS, at Syracuse, N. Y., showed that 1,744 ran from 1 to 18% fast; 3,035 from 1 to 32% slow; 616 were classed as correct, showing less than 1% variation; 616 failed to register; and one would not pass gas. Most of the meters running either fast or slow showed variations of 5% or less, and only 31 meters out of 1,744 ran more than 7% fast. The average excess registration for all the fast meters was 2½%, and for the slow, 3¾%. The tests were made by Mr. T. Littlehales, of Syracuse, N. Y., who states that in all his previous experience he had scarcely ever found a meter running over 8% fast. The poor registration at Syracuse, he attributes largely to the use of old meters of a defective type. We are indebted to the "American Gas Light Journal" for the above.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was caused by the failure of a high trestle under a freight train on the Kentucky Central branch of the Louisville & Nashville R. R. on Nov. 27. The trestle crossed a ravine a few miles south of Winchester, Ky., and was 65 ft. high. A number of bridge carpenters were at work underneath the trestle when it fell and two of these men were killed. The engine and tender passed the trestle safely, but the entire train of 32 freight cars, loaded with coal and lumber, was precipitated into the ravine.—— A switching accident on the Western New York & Pennsylvania R. R. at Buffalo, N. Y., on Nov. 26, resulted in the death of one and the injury of three track laborers, who had sought shelter from the rain under a freight car.——An explosion of steam heating pipes in a crowded passenger car on the Evansville Division of the Illinois Central R. R., near De Koven, Ky., which occurred Nov. 24, seriously injured two passengers and hurt a number of others.

A REAR END COLLISION near Tournay, about ten miles from Tarbes, France, which occurred on Nov. 24, resulted in the death of ten persons and the injury of a number of others. The press dispatches state that a ballast train ran into the rear end of a passenger train during a heavy fog.

DAMPNESS IN THE BOSTON SUBWAY, says the Boston "Evening Transcript," is causing some annoyance. This is caused by the condensation of moisture following sudden changes in temperature, and the chief inconvenience is felt at the stations. In the recent cold snap the subway was completely filled with cold air, and the steel structure was thoroughly chilled. The sudden rise in temperature following caused the condensation of moisture on the metal surfaces, and from these the water dripped upon the passengers at the stations. It became necessary to resort to rubber scrapers and cloths to remove the water.

BIDS FOR GARBAGE REMOVAL AND DISPOSAL AT Boston are to be received until Dec. 8 by the Street Department of that city. The contractor must remove the garbage from five points on the water front to a plant to be located on Spectacle Island on land owned by the city. Final disposal may be by some cremation or utilization process, selected by the contractor. The proposed contract will run ten years, from May 1, 1898. The city will have the right to buy the plant at the end of five years or at the expiration of the contract, the price to be fixed by arbitration in case the city and contractor cannot agree. All proposals must be accompanied by plans and specifications, description of the plant and copies of patent involved, if any; also by a statement of one or more cities where the proposed system has been in successful operation for at least six months. Mr. Benj. W. Wells is Superintendent of Streets. The invitation for proposals is dated Nov. 22, and thus affords bidders scant time for preparing complete plans and specifications.

THE LOWEST BIDDER FOR THE CHICAGO GARbage contract on Nov. 20 was Mulcaire & Burke, who offered to collect and dispose of the garbage of the whole city for five years for $1,800,749. It is said that the contractors propose to install the Merz utilization system, in case they secure the contract.

THE TREATMENT OF SEWAGE with electrolized sea water, at Bombay, India, is to be abandoned after a trial of four months, according to "Industries and Iron." The size of the plant is not given, but probably it was an experimental one. It was found that chlorine produced in this manner cost about double the same amount of "free chlorine" in chloride of lime, without allowing for capital charges on the plant. The process employed was known as the Hermite, after a Frenchman of that name. Several plants of this sort, more or less experimental, were erected in France and England a few years ago, but no large permanent plant was ever erected there, so far as we know. In this country the Woolf electrozone process was introduced at Brewsters, N. Y., in 1893, for the treatment of a small amount of sewage (see Engineering News, July 13, 1893). The plant was built and operated by the Department of Public Works of New York city, in the interests of the purity of the Croton water supply. Mr. Geo. W. Birdsall, Chief Engineer of the department, informs us that this plant is still in use, but that the treatment of a part of the Croton water supply with electrozone was discontinued after an experiment in 1893. An electrozone plant was established at Danbury, Conn., for the treatment of the sewage of that town, shortly after the Brewster plant was built, but in 1895 the courts decided that the sewage must be kept out of Still River, notwithstanding any treatment given it by the electrozone process, and a few months ago the city put in operation a system of intermittent filtration. We are indebted to Mr. Geo. C. Stevens, Superintendent of Water-Works at Danbury, for information regarding the status of sewage purification there. The electrozone process at both Brewsters and Danbury consisted simply in the discharge of a partially electrolized solution of salt and water into the respective outlet sewers.

A STEAM BOILER carrying a pressure of 3,000 lbs. per sq. in. was shown at the Stockholm exhibition by Mr. De Laval, the inventor of the well-known steam turbine and the centrifugal cream separator. The boiler is described as being merely a long concentric spiral tube, less than 1 in. in diameter, through which the water is pumped, escaping as steam at the end, where it is used to propel a steam turbine. The water supply is automatically regulated by the demand for steam, as is also the air supply to the furnace. Notwithstanding the extremely high pressure, the boiler is believed to be a very safe construction, on account of the small diameter of the pipe and of the fact that if an explosion should take place it would involve only a small portion of the length of the pipe and a small quantity of water.

PRIVATE CARS FOR THE PRESIDENT OF MEXICO.

The Mexican government is about to present to President Diaz two private cars which have been specially designed and built to the order of the government by the Pullman Palace Car Co., of Chicago, and we are indebted to the builders for photographs from which we have selected the accompanying views showing the luxurious character of the interior finish of the cars. The general dimensions are as follows:

Length over all	67 ft. and 68	ft.
Width over all	10 "	0¼ in.
Width over sills	9 "	8 ins.
Height over all	13 "	10½ "
Height from rail to center of drawbar.	2 "	10 "
Height from top of sill to under plate.	6 "	7 "
Wheelbase of trucks (six-wheel)	10 "	0 "
Wheels, diameter	2 "	9 "

The President's Private Room.

The Reception Room.

PRIVATE CARS FOR THE PRESIDENT OF MEXICO.
Pullman Palace Car Co., Builders, Chicago, Ill.

One of the cars contains the private apartments of the president and his wife, with state reception room and a large observation platform at the rear. The other is a dining car. The framing is of very substantial design, and the side trusses are strengthened by wrought-iron cantilevers extending back 16 ft. from the corner posts. The center bearings are of steel channels, and the body bolsters are double, 8 ins. wide. The flooring is double, with mineral wool packed between the floors and floor beams to deaden the noise of the wheels, etc. The bottom floor consists of a singer layer of planks laid transversely across the car and secured to the under side of the floor timbers. The upper floor, on top of these timbers, has two layers of plank, laid diagonally in opposite directions. The sheathing is of narrow vertical strips of whitewood, tongued and grooved, set with lead paint in the grooves and glued to the body timbers, every strip being secured by blind nailing. The whole of the side and end frames, between sills, plates, posts and panel rails, is filled in with ¾-in. blocking, closely fitted, glued and driven in to form solid walls which were planed to receive the sheathing. The ends of the cars, except the rear end of the private car, are fitted with Pullman vestibules the full width of the cars, the wrought-iron face plates being held together by buffer springs below the platform and above the hood. The Sessions steel platforms are used, and all the platform steps have a folding step below the bottom fixed step.

The cars are mounted on Pullman standard six-wheel trucks, with 33-in. Allen wheels having steel tires and iron centers. The treads of the wheels are of extra width, so that the cars can run safely on lines having a gage of either 4 ft. 8½ ins. or 4 ft. 9 ins. The Westinghouse brake is applied to all the wheels, the brake shoes being fitted to the National hollow brake beams with automatic heads. The axles are of steel, with journal bearings of phosphor bronze or Ajax metal, and the journal boxes have Fletcher lids. The National drawbar is used, with combination Miller & Janney coupler. The cars are heated by the Frumveller fireproof heater, in connection with the steam heating system of the Safety Heating & Lighting Co. Oil lamps are used, the cars being wired for electric annunciators, but not for lighting. The wiring is connected between the cars. The water for the toilet rooms and bath rooms is carried in tanks under the car, and forced through the pipes by air pressure, and if the overhead water tanks in the kitchen should become exhausted, they can be refilled from the water pressure tanks under the cars. A complete equipment of wrecking tools is provided.

In service the dining car is in front of the private car, and has the kitchen at the front end. Next to this is a regular sleeping car section, and then the dining room, the extension table of which will seat twelve persons. This room is finished in East India vermilion wood and upholstered in blue. Beyond it is a stateroom finished in mahogany, and beyond this again, at the rear end of the car, is an ante-room finished in oak. Both these rooms are upholstered in brown. The private car has at its forward end a baggage room, toilet room and heater room, a corridor 27 ft. long extending from the vestibule to the reception room at the rear of the car. Opening from this corridor are the private apartments of Mrs. Diaz and the president. The former are finished in prima-vera wood and decorated in the Louis Quinze style in blue and cream; the latter are finished in mahogany and upholstered in red. Beyond these apartments is the reception room, finished in vermilion wood and upholstered in green, and this opens upon the observation platform, the roof of which has a dome 7 ft. 3 ins. diameter and 2 ft. high. The decoration and upholstering of the cars is most elaborate and luxurious, and the builders state that the cars contain in all about 1,200 sq. ft. of glass in windows and mirrors. The metal decorative work is of red bronze.

The lower part of the body of each car, below the belt rail, is painted dark green, with cream color between the windows and buff above the windows. The name board is red, not lettered, but decorated in gilt.

WIDENING THE GAGE OF RAILWAY TRACK ON CURVES.

By Wm. H. Searles, M. Am. Soc. C. E.*

When a truck is passing around a curve the flange of the forward wheel is invariably pressed hard against the outer rail. It is the reaction of the rail that serves constantly to turn the truck in the proper direction. There can be no play at this point between flange and rail such as obtains on a tangent.

When the truck has but four wheels the other three flanges are not usually in contact with the rails, the trailing wheels dividing the play between them in some unequal ratio. The sharper the curve the nearer the rear flange will approach the inner rail, and the contact will be complete when the curve is such that a middle ordinate to a chord of twice the wheel-base is equal to the play allowed in setting the flanges originally. The rear axle now has a radial direction, and the line of the truck is tangent to the curve at the point of contact of the rear wheel, Fig. 1 A.

Upon a sharper curve than this the rear wheel is forced back of the tangent point, and its flange is not only in contact with the rail but grinds against it as the wheel tends to roll towards the inner rail, owing to the unfavorable angle between the axle and the radius drawn to the point of contact, Fig. 1 B.

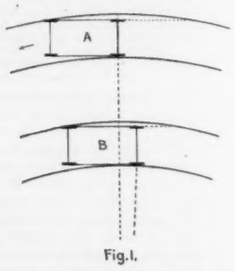

Fig. 1.

Fig. 1.—Diagram Illustrating Action of Four Wheel Truck Rounding Easy and Sharp Curves.

The sharper the curve becomes after this, the more will this unfavorable condition be aggravated, and the rational limit of curvature for a given length of wheel-base is that which permits the condition shown in Fig. 1 A. But the condition B is not a serious evil unless carried to excess, as may happen with an unusually long wheel-base upon a very sharp curve. Ordinary four-wheel car trucks never require any widening of gage. The original play is all sufficient.

Considering next a truck of six wheels, all flanged, and with equi-distant axles, if we suppose the truck to traverse a curve of gradually increasing curvature, we shall have at first only the forward flange in contact with the outer rail; later the rear flange will touch the inner rail and the rear axle will be normal to the curve; then as the tangent point creeps forward both rear and middle flanges will touch the inner rail; then the increasing pressure on the middle flange will pry the rear flange away from the rail, until finally the rear flange brings up against the outer rail and the middle axle is now normal to the curve, and the truck is wedged tight in the track between the three points of contact, Fig. 2 A and B.

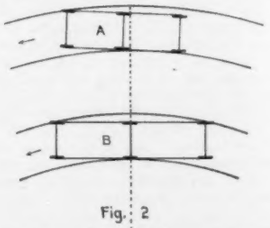

Fig. 2

Fig. 2.—Six Wheel Truck on Easy and Sharp Curves.

This happens when the middle ordinate to the chord of the wheel-base equals the play originally allowed in setting the wheels, and indicates the limit of curvature of track at which the truck

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will work without spreading the rails. This limit of curvature is expressed by the simple formula

$$D = \frac{3825\ p}{l^2} \qquad (1)$$

in which D = the degree of curve sought, p = the original flange-play in inches, and l = the rigid wheel-base in feet.

If the middle axle is not equi-distant from the others, let the distances be expressed by a and b in feet and the limit of curvature will then be

$$D = \frac{956\ p}{a\ b} \qquad (2)$$

This formula will apply also to the case of eight wheels, all flanged, should any such occur, by considering the axle nearest the middle, and the extreme ones, and ignoring the fourth.

But a more important study than the foregoing is that of locomotive action upon a curved track, both on account of the weight of the machine and also the length of rigid base in many cases. When there is no pilot truck and all the weight is on the drivers, the above formulas apply directly.

The center pin of the pilot truck is a fixed point in the engine frame which must be considered in connection with the rigid base of the driving wheels. However many driving wheels there may be, usually only two of them on the same side are flanged. Let the distance between these two in feet be denoted by b, and the distance from the forward one to the center pin be denoted by a. Then if there were no side-motion allowed in the center pin, formula (2) would apply to this case also. Fig. 3.

Fig. 3.

Fig. 3.—An American Type Locomotive on a Curve.

But as there is provision made for a side-motion in the center pin of about 1¾ ins. each way from the center line, this acts favorably in accommodating the engine to the curve and allows it to pass a sharper curve than it otherwise could. The result is as though a larger play had been given to the flanges. This additional play is not equal to the side-motion, but to a proportional part of it in the ratio of $\frac{b}{(a+b)}$

So that if s denotes the side-motion of the pin in inches and p the play allowed the flanges in inches, then the limiting degree of curve that will pass the engine will be

$$D = \frac{956}{a\ b}\left(p + \frac{b\ s}{a+b}\right). \qquad (3)$$

This formula is based on the conditions that the center pin has exhausted its side-motion; that the forward flanged driving wheel is in flange-contact with the inner rail, and that the rear driver flange is in contact with the outer rail.

Upon a curve somewhat flatter than the limit the driving flanges leave the rails and the engine is guided solely by the pilot-truck; but when the curve is so flat that the side-motion of the pin is but partially utilized, the engine is guided wholly or partly, as the case may be, by the forward driving flange against the outer rail. On a very flat curve the pilot does not guide at all.

When the pilot has but a single axle it is governed by a fixed center placed several feet to the rear of the axle, about which the axle is free to swivel to a limited extent. The side-motion is allowed and controlled by links, through which the weight is transmitted from engine to axle, and as these are directly over the axle, the distance a of the last formula must be measured from the axle in this case instead of from the center pin. The value of s may be taken at double its value in the preceding case, though it may vary with different engines and is best taken direct from the locomotive in question at the time. With these values for a and s respectively formula (3) applies to this case also.

These formulas are correct and easily demonstrated. The numerical coefficient is exact for a 10° curve, and practically so for any degree up to 16°.

For D = 20° use 960.
" " 30° " 966.
" " 40° " 975.
" " 50° " 986.

and for intermediate degrees in proportion.

A single example will show the application of these formulas. The 12-wheeler illustrated in the "Railroad Gazette" of Sept. 24, 1897, has four drivers on a side, the first and last flanged. From the center pin of the 4-wheeled truck to the first driver is 7 ft. = a. From the first driver to the last is 15 ft. 6 ins = b. The side-motion of the center pin is 1¾ ins. = s. If the flanges are set to the standard p = ⅞-in., we have all the data necessary for solving formula (3) and we find that

$$D = \frac{960}{7 \times 15.5}\left(.875 + \frac{15.5 \times 1.75}{7 \times 15.5}\right) = 18°.41 = 18° 25'$$

This engine therefore requires no widening of the gage up to an 18° curve. But if the play of the flange on a tangent were but ⅝-in. this engine would be limited to a 16° 12' curve.

We have now to consider the question of widening the gage on curves sharper than the limit. For this purpose we solve equation (3) for p but write P to indicate the total clearance required. Thus,

$$P = \frac{D\ a\ b}{956} - \frac{b\ s}{a+b} \qquad (4)$$

and subtracting from P the actual flange play p, the remainder is the amount of widening required. This formula is general; for if there be no side motion of the center pin, or in the case of any six coupled wheel-base, s is zero, the last term disappears, and the remaining expression is the same as we should derive from equation (2). For high degree curves we may substitute the appropriate coefficient as already explained.

Taking the same engine, what widening is necessary for it to pass a 22° curve?

$$P = \frac{22 \times 7 \times 15.5}{960} - \frac{1.75 \times 15.5}{22.5} = 2.486 - 1.206 = 1.280$$

ins.

Then P − p = 1.280 − .875 = 0.406, say 7-16 in.;
or, if p = ⅝-in., 1.280 − .625 = 0.655, say ⅝-in.

other cases would be solved in a similar manner.

It will be observed that the widening depends on the degree of curve, the distances between flanged wheels in rigid system, or between these and the pilot truck in a flexible system, the side-motion of the pilot, and upon the play allowed between flange and rail on a tangent.

It is independent of grade, of elevation, of outer rail, and even of the gage, except so far as running foreign wheels of a different gage upon the track may affect the play or clearence.

The report of the committee on standard wheel and track gages of the American Railway Association upon this subject, which was published in Engineering News of Oct. 14, shows not only wide variations in practice, which might be expected, but also great diversity of view as to the reasons for widening the gage in any case. Our formulas show that there is little opportunity here for indulgence in theory. It is a simple mathematical problem, and susceptible of exact solution in each case.

It would seem that too much fixed play may be allowed. The time was when ½-in. play was thought sufficient, then ⅝-in. was the standard and now it is ⅞-in. This has probably grown out of the necessity for introducing the compromise gage. But inasmuch as foreign locomotives seldom traverse the track, a nice adjustment of engine and track should be possible on every road, keeping down the free play to a reasonable amount and widening the gage according to formula on curvature above the limit.

Widening should affect the inner rail only, leaving the outer rail true to the curve, especially where spirals are used. The objection to widening based on interference with the guard rail is not well taken, if the guard rail is spaced, as it always should be, from the opposite, not the adjacent rail.

With the given data taken from the ruling engine upon any road a table of proper widening for each degree of curve above the limit can be prepared in an hour or even less time, and by supplying copies of this with orders to trackmen a perfect uniformity of track in this regard may be secured, doing away both with unnecessary looseness of gage, and with unnecessary friction on curves, loss of power, flange-wear, rail wear, spreading of rail and drawing of inside spikes, all of which evils grow out of forcing a locomotive through a track too narrow for it.

AUTOMATIC SIGNALS.*

By V. K. Spicer.**

The most practical and satisfactory form of automatic signaling for railway purposes is that which is based on the electric rail circuit principle. This fact has been practically demonstrated in hundreds of cases where such apparatus has been in use for a number of years, the apparatus being carefully made and as carefully maintained. The experimental stage has long since been passed, and to-day automatic signaling is as much an assured success as the automatic air brake.

The automatic signals placed for the protection of passengers and vehicles at highway crossings with railways are familiar, but the absence of any such signal is, perhaps, the most familiar feature of highway crossings generally. The crossing sign, dumb and unheeded, is usually in evidence, and in its various disguises serves the purpose of relieving the railroad company's conscience at a trifling cost.

The existence of a variety of automatic signals is evidence enough of the demand for them and a natural desire on the part of inventors to fill it. Almost as many different devices have been produced as there have been inventors, mostly based on the greater or less degree of knowledge and experience each has of the requirements and conditions, not only of the apparatus, but of the situation where it is applied.

Track instruments have given way to the track circuit, as is evidenced in present successful automatic signaling practice. For this there are two principal reasons; 1st. Every foot of track is an active factor in the performance of the signal; 2nd. It presents the least number of elements in its maintenance. Any part of a train, or any pair of wheels, will actuate the signal of the locality protected as long as such train, or wheels, remain on the rails of the section, whether moving or at rest. Likewise, any failure of batteries, instruments, connecting wires, rail joints, insulations, the rails themselves, or of switches within the section, will immediately be indicated by the signals. In the second place, there is an entire absence of any mechanism or working parts exposed to the action of trains or coming under the observation and care of the ordinary track repairman. There is also no part of the apparatus attached to the engine and cars, so that all foreign rolling stock receives the same protection as that regularly belonging to the road equipped. The practical maintenance of the track circuit system is, therefore, most economically installed and maintained. Allowing that the management of the railway has provided an experienced signal engineer, with the necessary force under his charge to maintain the signal apparatus, it remains for the manufacturer to furnish the best suited for the purpose.

If an audible signal is desired, it should be loud enough and strong enough to be heard for the farthest distance, and should be made to do this under all conditions. If a visible signal, it should be the most prominent and noticeable in form which will convey its indications in the most distinct manner to the farthest distance under all conditions of clear and obscured view. An audible and visible signal is an essential at a highway crossing. The addition of a tangible indication of danger would undoubtedly be of benefit.

A visible signal is depended on mainly in railroad operation, although in special instances audible signals in the form of bells, whistles and torpedoes are frequently used as supplementary adjuncts. Deflecting or derailing switches, scotch blocks, gates, and even attachments for setting the air brakes are features in extensive use, also in connection with signals. The cheapest and most satisfactory arrangement for signaling at a highway crossing is that employing the track circuit, with a substantial sign including a visible signal and a loud bell, operated by purely electric power. The signal should be readily visible from all approaches to the crossing, and the bell easily heard under the most adverse circumstances. Both should be operative for a sufficient time before the train reaches the crossing, to allow passers-by to move out of danger. Both must be reliably operative and never give false indications.

Such signals are being made and put in service every day on railroads ready to pay for and maintain them in successful operation. The cost of installing, together with that of maintaining, would form a small fraction of the cost of one accident arising through no such protection being offered. These signals never sleep or get drunk, or

*Abstract of a paper presented at the November meeting of the Railway Signal Club, Chicago, Nov. 16.

**Chicago Agent, Union Switch & Signal Co.

leave their post of duty, and their keep costs less than the coal used in heating watchmen's houses.

The forms of signals have been various, but the "semaphore" pattern has, from its first adoption in 1841, on English roads, been the best, and it can be seen and its indication distinguished from a greater distance than any other. Its adoption as an electrically operated signal has been desired, but until the recent perfection of economically operated electric motors was accomplished, this was not practical. To-day we have the electric semaphore signal in such a state of perfection that there is no reason for the adoption of any other form. It is applied and operated with more satisfaction and at no greater expense than for the best forms of the less satisfactory color signal enclosed in a case, behind glass windows, and distinguishable for a limited distance only under the most favorable conditions of atmosphere and background.

One form of the semaphore style of signal, used for block signaling purposes is shown in the accompanying cut. The post is made of iron tube, about 4 ins. diameter, mounted on a cast-iron base, which contains the operating mechanism. The rods connecting the mechanism with the signal at the top are enclosed in the post, and ball bearings are used for shafts, pins, etc., reducing the friction to a minimum. The semaphore blades are made of aluminum, covered with a composition of color which withstands the action of heat and light without change, so that frequent painting is dispensed with. While no attempt has been made to prevent the accumulation of snow and ice on the blade and its mountings, the design of these parts is such that the most extraordinary collections arising from natural causes will not affect the adjustment or action of the signal. The power produced through the motor and mechanism is exerted only in setting the signal to the clear position. All connection with this mechanism is severed when the "stop" position is produced, and the signal assumes that position by reason of the action of gravity on its counterweight side. This counterweight constitutes the entire load which must be lifted by the mechanism in clearing the signal, and represents fully 1,000 times what would be necessary to operate a semaphore in balance on its shaft, or the ordinary disk of an enclosed signal, so that the stop position of this semaphore is correspondingly assured under all circumstances requiring it. As this is available at a cost far inferior to that for manual block signaling, there seems no valid reason why every railway doing a moderate amount of business should be longer without substantial protection against accidents which block signaling can prevent. Such accidents are prevented in measure with more or less success where the enclosed automatic disk signals are employed. These, w e no less expensive, are far inferior, as they are not readily visible or distinguishable from a distance, and particularly so under the least unfavorable conditions of light, atmosphere and background. The semaphore is the ideal signal, and can be made visible at night by the use of illuminated semaphore blades.

Discussion.

Mr. Cade (Standard Railroad Signal Co.) did not think that automatic electric semaphores had been in use long enough or to a sufficient extent to warrant the claims made in the paper. While much is made of the fact that automatic signals do not go to sleep or get drunk, yet it must be remembered that they are sometimes deranged by lightning and frozen up in winter. In regard to the time limit, allowing an engineman to pass an automatic signal at danger if it does not give a clear indication in a certain number of minutes, he thought this practically meant permissive working, which system is much less likely to be used in connection with manual-controlled signals, since the tangible evidence of the written order required to be given by the operator to an engineman to permit him to pass a signal at danger acts as a check upon the too free use of permissive working.

Mr. Salmon (Hall Signal Co.) said that superintendents who have numerous automatic signals, well made and properly installed, consider them as good as any signals on the road, and he questioned whether the general objection as to engineman running past these signals (having no fear of being reported) has much foundation in fact. Where the cost of operating manual signals has led to the use of very long block sections, he thought the automatic system, with shorter blocks, would be cheaper and safer. The use of ball bearings, noted by the author of the paper, is an important innovation, as by thus reducing the friction less current is required to operate the signal.

Mr. Elliott (C., M. & St. P. Ry.) said that while automatic signals are approved by signal engineers, they are very generally disapproved of by superintendents and men of practical experience on the road, mainly for reasons connected with the discipline of the enginemen. The most common objection is that as there are no operators, the enginemen will, on occasion, run by the signals when trying to make up time, etc., and finding that no accident results and that no report is made they will get in the habit of disregarding the signals. While it is sometimes claimed that enginemen do not run past automatic signals, yet the fact remains that they do so, as he has found by personal experience. The freezing of these signals can be easily guarded against and prevented.

Mr. Gillingham (Ill. Cen. R. R.) referred to the successful experience of his road with automatic signals during and since the time of the Columbian Exhibition. The heavy exhibition traffic was conducted with such a degree of safety as to indicate that enginemen do not disregard the signals. He has in service several automatic semaphores, which have not ball-bearings, and as a result of their satisfactory working several more (fitted with ball bearings) are to be installed. They have given no trouble from freezing or from failure of the batteries.

One of the members considered that trainmen should be more carefully instructed as to the signal service, and examined as to their knowledge, on the same lines as the instructions and examinations as to train rules and air brake practice.

A WATER PURIFYING PLANT.*

By Howard Stillman, M. Am. Soc. M. E.†

About a year ago the Southern Pacific R. R. Co. established at Port Los Angeles, Cal., a plant or adjunct to the pumping station for the purpose of purifying the water supply at that point of the large amount of scaling matter it contained. The chemical principles involved are based on the well-known Clark or Porter-Clark process. The purpose of this paper is to describe the method as well as the "standardizing" of the process, since the plant referred to was established with a view to rendering the same applicable to other stations on the company's lines where the waters require purifying.

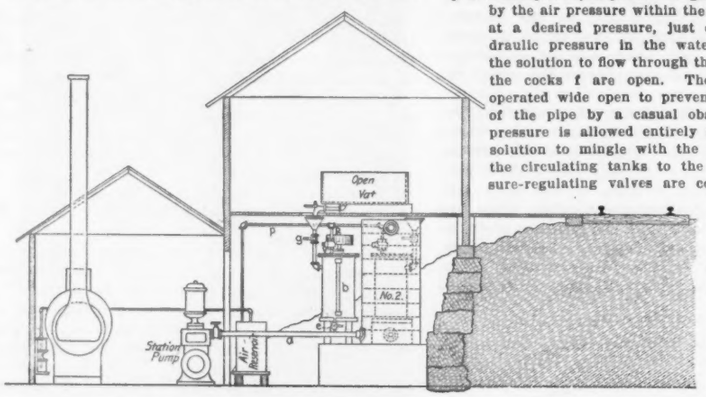


FIG. 1.—SECTIONAL ELEVATION OF WATER PURIFYING PLANT AND PUMPING STATION AT LOCOMOTIVE WATER TANK, PORT LOS ANGELES, CAL.

At certain places in England and elsewhere large and expensive plants have been put up for the purpose of purifying water for boiler purposes on a large scale. The method which we are to discuss is intended to do away with an elaborate system of works and to furnish a continuous supply of purified water of constant quality without the use of agitators to assist chemical action or the necessity for labor other than that in usual attendance at a water station. It was also desired to do away with expert atention at remote points and avoid the danger of overdosing the supply, or going to the other extreme, with chemical solutions.

The treatment of water in the cold on a large scale was considered the cheapest and best method of dealing with it. No two waters from a natural source are just alike, and the treatment by boiler purges, compounds and nostrums, frequently exploited, is properly of value only in special cases.

On a railroad where steam boilers take water successively from various sources of differing quality the "cure-all" becomes a factor of doubtful value or even safety. The old saying that what is one man's meat is another's poison is equally applicable to steam boiler waters.

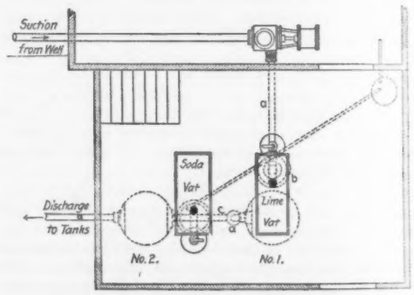
The consideration of each water by itself, and its reduction to lowest terms practicable with respect to the scaling and corrosive matter contained, seemed the best course to pursue.

The water of Port Los Angeles required a double treatment on account of the bi-carbonate of lime contained, together with a large amount of the sulphates of lime and magnesia.

The following is a description of the appliance:

The general plan (Fig. 1) shows a section elevation and Fig. 2 a plan of the purifying addition and pumping station. Referring to Fig. 1, the water main, a, a, is intercepted in its passage from the pump to supply tanks (Fig. 3) by the circulating tanks, Nos. 1 and 2 (Fig. 1). The construction of these tanks is shown in Fig. 4. They are each about 4½ ft. in diameter by 8 ft. high, and the space inside is divided up by partial diaphragms, alternately placed, allowing the water in its course to circulate upward, under and over, and check its motion, allowing time for chemical action to take place within them. Their size is such as to allow the water about five minutes in passing through. The circulating tanks are not intended to deposit or dispose of sediment. The water main enters tank No. 1 at the bottom and discharges at the top, thence to bottom of No. 2, again discharging at top, and on to the supply and settling tank (Fig. 3).

Just before entering each of these circulating tanks the water main is tapped by a ½-in. pipe, conveying in a steady stream, when in operation, a solution of desired chemical reagent from the chemical tanks at b, c. These chemical tanks are shown in detail in Fig. 5 and the ½-in. feed-pipes leading from them, e, e, are controlled by the plug cocks f, f. These smaller tanks are also of fine dimensions, and hold 100 gallons when charged with solution, which suffices for four hours' continuous operation of the pump, or a supply of about 44,000 gallons of water. As shown in Fig. 5, the tanks are air-tight when all cocks are closed, and are filled through the 1¼-in. pipe and screened funnel when the cock g is open. The top is tapped by a ¼-in. pipe leading from an air reservoir supplied with compressed air from an 8-in. Westinghouse pump. Just before entering the tanks the small air-pipe p is intercepted by a pressure-regulating valve, v, whereby the air pressure within the chemical tanks is kept at a desired pressure, just overbalancing the hydraulic pressure in the water main, and allowing the solution to flow through the ¼-in. feed-pipe when the cocks f are open. These cocks are always operated wide open to prevent possible clogging up of the pipe by a casual obstruction, and the air pressure is allowed entirely to control the flow of solution to mingle with the water flowing through the circulating tanks to the reservoir. The pressure-regulating valves are controlled in the usual manner by wrench and screw at bottom, so that the operator can occasionally adjust the feed of solution. Each chemical tank is about 4 ft. high, and provided with a long sight-feed glass so that the contents can always be noted. They are gaged to feed out 11 ins. per hour, and when pressures are adjusted do not ordinarily vary. Occasional attention to the pressure valve during pumping hours, such as an engineer gives his sight-feed lubricators to steam engine or pump, is sufficient, inasmuch as the hydraulic pressure during pumping hours does not vary more than the head varies in a gravity supply. It has been found that the air pressure on the chemical tanks is about an atmosphere less than hydraulic pressure in the main, so that, as would be expected, the pneumatic action is to hold back the solution from flowing out too fast. As referred to above, this feed could have been regulated from the cock e, or the pipe made smaller,



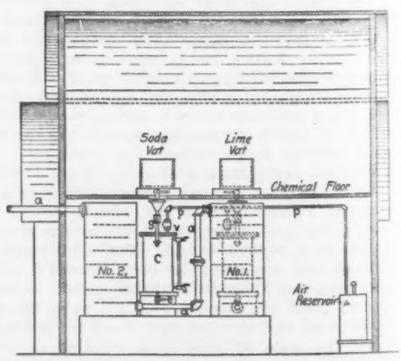


Fig. 2.—Plan of Apparatus for Preparing Chemicals.

*Abstract of a paper presented at the New York meeting of the American Society of Mechanical Engineers.

†Engineer of Tests, So. Pac. Ry. Co., 1315 23d St., Sacramento, Cal.

but it was desired that at no time should the operation "hang fire" by clogging of a small opening. When the pumping ceases the cocks e in feed-pipes are immediately closed, and when again pumping is renewed the cocks are opened. At Port Los Angeles the hydraulic pressure is about 92 lbs. gage, and the discharge of the pump a little over 11,000 gallons an hour.

The chemical tanks are filled as required from the mixing vats, on the floor directly overhead, which is on a level with the track, as shown in Fig. 1. These vats are open and have 1¼-in. pipe connection at bottom, terminating in plug cocks opening downward through holes in the floor directly into the screened chemical tank funnels, for convenience in filling. The vats are rectangular in form and of such size that a 12-in. depth of liquid fills a chemical tank for four hours' continuous run of pump. The weight of chemical material per 12-in. depth of liquid in the open vat gives a standard solution, and is based on the quality of the water and its hourly rate of flow through the main to the reservoir, which data give the key to the situation; as, for instance, supposing analysis and tests of the water show that it will require 1.64 lbs. of unslacked lime to absorb the carbonic acid in 1,000 gallons. The flow through the main being 11,000 gallons per hour and the charge to last 4 hours, then we have $4 \times 11 \times 1.64$, or 72 lbs. of lime to be slacked with water to a depth of 12 ins. (100 gallons) in the mixing vat. When slacked and mixed the liquid is a cream of lime, which is run off into the chemical tank when desired, as before stated.

The old English method of treatment required the lime water, or lime in solution only, to mingle with the supply being treated, and large tanks with agitators were provided for the purpose. It has been proven that such elaborate means are not necessary and that in condensed form as cream of lime the chemical action is just as effective by the method described, the agitation being accomplished in the passage of the water supply through the circulating tanks or an equivalent arrangement to effect the purpose.

It requires about five minutes' time to refill the chemical tanks and recharge with air, at which time the water supply, or pump, is stopped. The tank charged with cream of lime is provided with an upright revolving shaft carrying paddles, as shown in Fig. 5, and works through a stuffing box in the top by means of a small air motor. The paddles revolve when the tank is feeding into the main, and their purpose serves to stir up the milk of lime to prevent it settling out, and thus deliver a constant amount of lime to the water being treated.

We have just considered the operation of introducing quick-lime into the water in proper proportion to effect absorption of carbonic acid and consequent precipitation of carbonates in solution. The roily water now passes on through circulating tank No. 1, and this part of the desired reaction occurs more or less completely. As referred to above, the water supply at Port Angeles contains, besides the carbonates in solution, a large amount of sulphates of lime and magnesia.

These salts, not being converted by quick-lime, require a second reaction. The use of the necessary amount of caustic soda to effect this would have been expensive, besides other objections to its use. Soda ash was good and cheap, but would react with the lime,

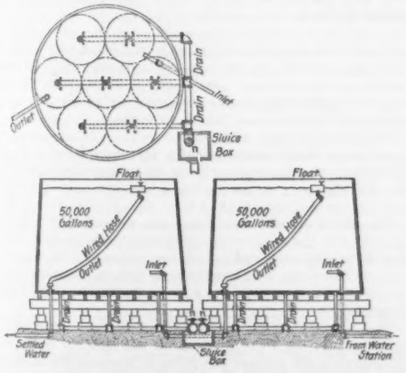


Fig. 3.—Plan and Sectional Elevation of Storage Tanks.

directly, to form carbonate of lime if introduced with it; hence its use necessitated the second chemical tank, with its mixing vat, which is operated by the same method and simultaneously with the lime tank.

If the cream of lime and carbonate of soda were injected into the supply main from the same chemical tank, or in mixture, a series of chemical reactions would be set up which would theoretically terminate in the desired result; but there would be a large amount of chalk formed directly, and there are other reasons why it seemed best to keep the reagents separate and make of it a double continuous process.

The soda tank is like Fig. 5, except that it requires no stirring device, as the solution is some distance from saturation and does not settle out. The weight of soda ash put into the soda mixing vat is dependent on same data as before: the amount required to convert the sulphates being 2.2 lbs. (per 1,000 gallons), we have $4 \times 11 \times 2.2$, or 96 lbs. to be dissolved in water to 12 ins. depth in the mixing vat.

The lime is prepared by placing the stated weight of a good commercial article (fresh burned preferred) in the vat and letting in from an adjacent hydrant enough water to slack, after which more water is added to the required 12-in. depth. The soda is prepared in its vat in the same manner, except that it is simply a matter of solution which is quite strong yet not saturated, hence no separation or crystallization of sal soda occurs in the chemical tank.

As the water in the main receives its second injection from the soda tank, it passes on through the circulating tank No. 2, where the carbonate of soda effects its reaction more or less completely, and thence on to the storage and settling tanks, which are at least large enough to contain 24 hours' supply. The treated water is milky with precipitated carbonates, and discharges through the inlet pipe about 4 ft. from the tank bottom. The outlet to this tank is a piece of 4-in. wired hose, the open end of which attaches to a float on the surface, as shown in Fig. 2. By this means the clearest water in this tank passes on to the second similar tank by the same method. Clear water is always obtained from the surface outlet of the second tank.

The chalk deposit is considerable at the bottom of the settling tanks and has to be drawn off occasionally, which is effected by the "spider-drain" system shown in Fig. 3, which consists in tapping the tank bottom with seven 4-in. drain pipes. The location of these drains is shown in the plan of one of the tanks (Fig. 3), the drainage areas being indicated by the tangent dotted circles.

The vertical 4-in. drain pipes open into larger horizontal pipes, and these into a 9-in. pipe at right angles, terminating in the sludge valve shown at n, Fig. 3. This valve discharges downward into the sluice box, and when opened the tank bottom is drained from seven equidistant openings, which keeps the chalk deposit down near the tank bottom and prevents the "angle of slope" which the deposit would assume with but a single central discharge, whereby the deposit would accumulate up along the sides of the tank to interfere with clear settling, and would also require an occasional scraping or shovelling out. Each of the tanks is provided, independently, with this spider-drain arrangement, though both sludge valves discharge into the same sluice box.

Experiments were made in the laboratory by the author on the time practically required to complete the chemical reactions. During the first hour after treatment it was noted that the sediment or chalk forming in addition to that deposited, showing that chemical action, as far as observation would show, was not complete, though at the end of two hours no more precipitation occurred even in decanted water if left standing some days.

While for practical purposes it has been determined that sufficient tankage for a day's supply is ample to insure settled water, the system can be used by putting up a number of smaller tanks with less total capacity than a day's supply, provided the surface water from each tank drains to the lower part of the next, and so on, the final supply coming from the tank farthest from the water station. This, however, is a matter of circumstance and expense dependent on local conditions.

The following analyses are shown of the Port Los Angeles water supply in tabulated form "before" and "after" treatment. The analysis "before" is one of several which were made at intervals during a year previous to putting in the treating system. None of these analyses varied materially with the season. The analysis "after" was made about two months after the system went into operation, and is also one of several made during the past year, without showing material variation in the treated supply.

Analyses of Water from a Well in Bed of Santa Monica Canon, about 100 yds. from Pacific Ocean Beach.

	Before purification.	After purification.
Date of analysis.....	March, 1896.	December, 1896.
Treatment per 1,000 gallons.		Lime, 1.64 lbs. Soda ash, 2.2 lbs.
Contained in the water in solution in grains per U. S. gallon:		
Carbonate lime	14.29	.69
Sulphate lime	5.07	.29
Carbonate magnesia	1.22	7.15
Sulphate magnesia	17.15	1.63
Silica	1.34	.11
Alumina	.17	.17
Sulphate soda	5.56	27.02
Chloride soda	8.75	5.71
Total	51.55	43.67
Incrustating matter.....	39.24	10.04
Non-incrustating matter.	12.31	33.63
Cost per 1,000 gallons to treat, 4 cts.		

There is shown to be 7.15 grains per gallon carbonate of magnesia remaining in solution. Its presence seems due to the fact that the well water contained more carbonic acid than allowed for as in combination with carbonate of lime; hence the carbonate soda in its reaction with the sulphate magnesia produced, in part, the soluble bicarbonate of magnesia. It was found subsequently that an increase in amount of quick-lime from 1.64 to 2 lbs. per 1,000 gallons reduced the carbonate magnesia to about 3 grains per gallon, without an excess of lime showing in the treated water.

The analysis shows almost 28 grains of the neutral sulphate soda. This alkali is not desirable, as having a tendency to produce foaming if allowed to become too concentrated in the boiler, but is neutral in other ways as affecting water for boiler use. Its presence is unavoidable as being the direct product of soda ash and magnesia sulphate ($Na_2CO_3 + MgSO_4 = MgCO_3 + Na_2SO_4$). The greater portion of the $MgCO_3$ is precipitated, but the soluble Na_2SO_4 necessarily remains, and, like other alkali salts, can only be removed from a water by evaporation.

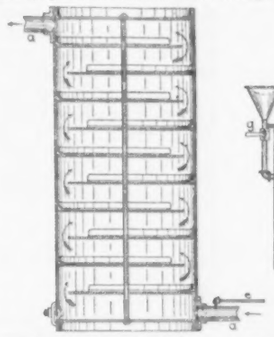


Fig. 4.—Section of Circulating Tank Showing Diaphragms.

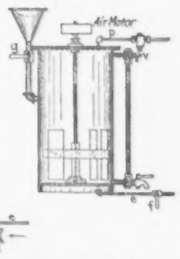


Fig. 5.—Section of Tank for Mixing Cream of Lime.

While the treated water is not shown to be "purified" in the proper sense of the term, yet it is converted to a fairly good water for boiler use. Previous to treatment the water formed a large amount of very hard scale, with considerable corrosion. I have seen pieces of this scale 1½ ins. thick and weighing over a pound, which could be best pulverized on an anvil. Analysis of this scale showed it to contain very much more of the hardening element (sulphate of lime) than was due to the amount of that element existing in the water before use; hence it seemed most probable that superheating of firebox plates to force heat through the intervening scale to make steam led to decomposition of the sulphate of magnesia, forming, with the carbonate of lime, more sulphate of lime and carbonate of magnesia. The superheating of the plates from the cause stated would possibly lead to decomposition of a film of water next to them and account for the corrosion, as oxidation under these circumstances would seem bound to occur ultimately.

Before treatment the water badly corroded the supply pipes or water main leading to and from the supply tanks. I believe this corrosion was due to the carbonic acid in the water.

A switch-engine with clean boiler was put to work on the wharf at Port Los Angeles, using only treated water, not long after the plant was put in operation, and observations made at intervals on the action of the water. No scale forms from its use, but a small deposit of magnesia sludge, having no tendency to form scale, has at times been observed. Otherwise the treatment has greatly improved the quality of the supply.

As to the chemicals used for treatment, there are other reagents in the market for the purpose. Fluoride, phosphate, and hydrate of soda are among these and with which experiments were made, but the market price of these materials is not comparable with the dry carbonate, or soda ash, for the results produced. If, for instance, we wish to reduce the sulphate of lime in a well water (permanent hardness), it is practically immaterial whether the precipitate formed is fluoride or phosphate of lime, the neutral sulphate of soda (or potash) will remain as formed in the chemical exchange of bases. The phosphate acts somewhat quicker and the precipitate is heavier and settles sooner, but its cost is incomparable with soda ash (90 to 94% absolute Na_2CO_3) at less than 2 cts. per lb.

As concerns the "temporary hardness" in natural waters produced from bi-carbonates of the scale forming bases, there seems to be no better or cheaper method of reduction than by use of quick-lime. No reagent obtainable at the price will absorb carbonic acid more greedily. It is itself precipitated as carbonate of lime by the carbonic acid which it has taken up, and in thus depriving the naturally contained carbonates of their solvent allows them to precipitate also. Besides this, it will throw out of solution iron and silica to a certain extent as well as organic matter.

Some waters, from absence of incrustating sulphates, do not require double treatment. For such stations the lime treatment alone is sufficient, and one tank, Fig. 4, with its adjacent circulating tank, Fig. 3, is made to serve.

The "standardizing" of the process for treatment of such waters as may thereby be benefited has been based on the following principles:

All tanks, vats, etc., to be made in sets of three sizes, the smallest being adapted to water stations having a delivery of 4,000 gallons per hour or less, the second 4,000 to 8,000 gallons, and the third 8,000 to 12,000 gallons.

Storage and settling capacity for a station to be sufficient for at least 24 hours' supply, unless circumstances allow other arrangement as to settling.

The character (from analysis) and rate of flow of water at a station being known, it remains to substitute such weight of reagents in a circular of direction, properly posted at the water station, as will supply necessary instruction to a person of ordinary intelligence.

TRIPLE EXPANSION PUMPING ENGINE FOR THE CITY OF MEXICO.

On Aug. 8, 1896, the Board of Sanitation of the City of Mexico issued a call for proposals from steam engine and pump builders for a steam engine to work one or more pumps, "capable of introducing in the pipes which are to serve for conduction water to wash the sewers, 1,000 liters of water per second, with a pressure equivalent to a column of water 12 meters in height."

The call for bids was advertised both in Europe and the United States, and when the bids closed, on Nov. 14, 1896, proposals had been received from a large number of engine building firms, including several United States firms and firms in several European countries. All these bids were referred to a technical commission of seven engineers, headed by Roberto Gayol, M. Am. Soc. C. E. This commission decided unanimously that the propositions presented by the Holly Manufacturing Co., of Lockport, N. Y., were the most suitable for the work to be performed, and on Jan. 23, 1897, a contract was executed with this company, for one vertical triple expansion, crank and fly-wheel, pumping engine of 24,000,000 U. S. gallons daily capacity, and three Stirling boilers, any two of which must be capable of running the engine at full speed. The contract required that this pumping engine and boilers should be delivered in the City of Mexico before Sept. 1, 1897.

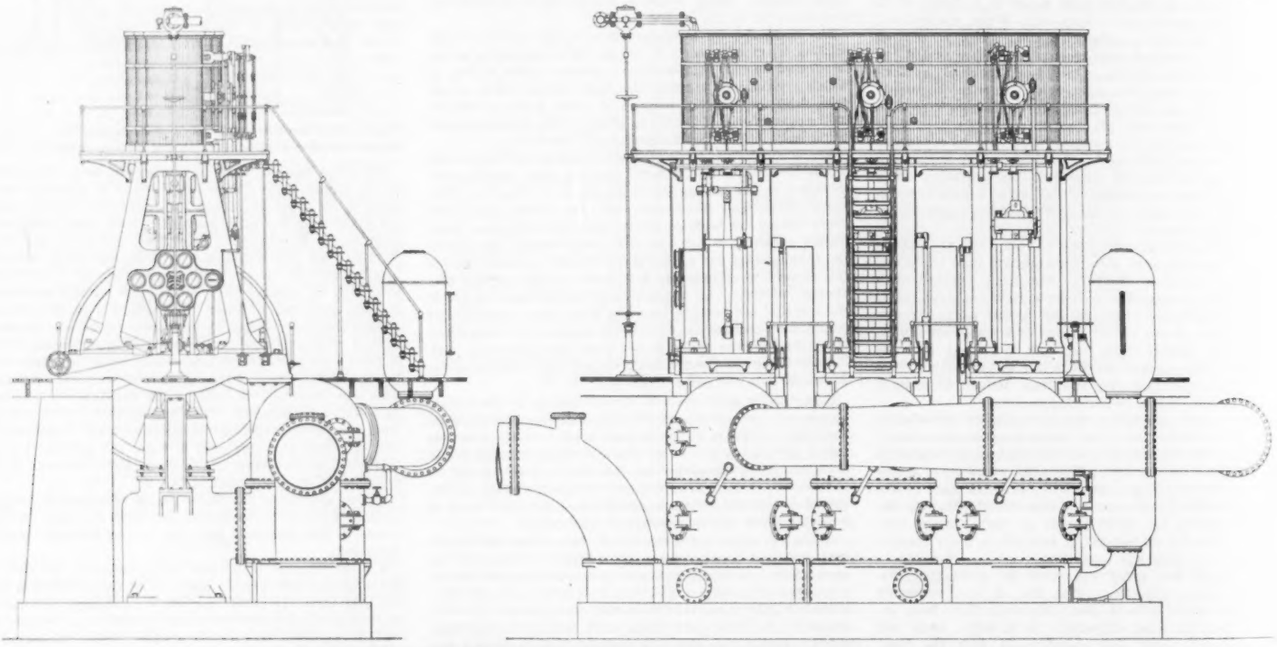
The contract required that the pumping engine and boilers should be delivered in the City of Mexico on or before the last day of August, 1897; and notwithstanding the magnitude of the work and the short time allowed for its construction the pumping plant was delivered complete in the City of Mexico two weeks in advance of the date specified, having been forwarded by a train made up for the purpose, consisting of eight 40-ton flat cars and one 40-ton box car of the St. Lawrence & Adirondack R. R. The shipment was routed in care of the Mexican Central R. R., via the New York Central & Hudson River R. R., the Michigan Central R. R., the Cincinnati, Hamilton & Dayton R. R., the Louisville & Nashville R. R., the Southern Pacific R. R., the Mexican International R. R., and the Mexican Central R. R. to the City of Mexico, and by the La Piedad Surface R. R. to the pumping station. The train arrived in the City of Mexico—3,036 miles distant—in twelve days from the date of shipment; which is claimed to break the record for long distance foreign shipments of this character.

The pumping plant as a whole, including the boilers, is required to perform on test an actual duty which shall be as minimum 30,500,000 kilograms for each 100 kilograms of "Cardiff" coal, "Crown brand," equivalent to 101,284,000 ft. lbs. per 100 lbs. of coal.

The accompanying cuts show the front and side elevations of the engine and pumps. The engine is of the vertical triple expansion type, having cylinder diameters of 18 ins., 31¼ ins., and 46 ins., all having a stroke of 36 ins. There are three single-acting outside packed plunger pumps having separate valve chambers, which form supports for one end of the engine bases. The pump plungers are of the same stroke as the steam pistons, and connected thereto by distance and piston rods through the upper cross-head. The engine is provided with a jet condenser, and the air and feed pumps are driven directly from the low-pressure cross-head. The valve motion of the steam cylinders is of the Corliss pattern, the admission valves on all three steam cylinders being of the drop cut-off type. The admission valves of the high-pressure cylinder are controlled by a speed governor, while those of the intermediate and low-pressure cylinder are adjustable by hand. The boilers, three in number, are of the water tube type, of a nominal capacity of 125 HP. each, and were manufactured by the Stirling Boiler Co., of Barberton, Ohio.

In designing the engine the builders sought to combine high economy in fuel consumption with strength, simplicity, and accessibility of parts, endeavoring to reduce to a minimum the cost of maintenance and repairs—very desirable qualities in a machine located in a country where the cost of coal is high and skilled labor scarce.

To American manufacturers, a very gratifying feature is the fact that in competition with European bidders on this work the superior quality of the articles offered, and the excellence of design were determined to more than offset any difference in price in favor of foreign manufacturers.



VERTICAL TRIPLE EXPANSION PUMPING ENGINE OF 24,000,000 GALLONS DAILY CAPACITY.
Designed and Built by the Holly Mfg. Co., Lockport, N. Y., for the City of Mexico Sanitation Board.

TEST OF CENTRIFUGAL PUMP AND CALIBRATION OF WEIR AT THE BRIDGEPORT PUMPING STATION, CHICAGO.*

By R. C. Carpenter, M. Am. Soc. M. E.†

The test described in the paper was conducted for Messrs. R. W. Hunt & Co., for the city of Chicago, in July, 1893, to determine the efficiency and capacity of the various pumps at the Sewerage Pumping Station at Bridgeport, Chicago. The writer, in conjunction with Mr. John C. McMynn, acted as engineer of tests.

Description of Plant.—The plant was constructed for the purpose of delivering sufficient water from Chicago River into the Illinois and Michigan Canal to induce a current to flow from Lake Michigan toward the pumping station and into the canal, so as to prevent the discharge of sewerage into Lake Michigan. The canal connects Lake Michigan with a tributary of the Mississippi and descends to the level of the Chicago River by a lock which has a lift of about 8 ft. in times of low water and 3 to 5 ft. in times of high water. The pumps are required to raise the water from Chicago River sufficiently high to be discharged into the canal.

The machinery of the pumping station was built by the Quintard Iron Works of New York city, and was installed in 1884. It consisted of four cross-compound engines, each 18 and 34 ins. diameter of cylinders and 34 ins. stroke, of the vertical type, with Meyer cut-off valves, each of which was directly connected by means of a long connecting rod to two centrifugal pumps.

The engines were designed to run at 100 revolutions per minute and to develop 400 I. HP. with 90 lbs. steam pressure. The total capacity of the station was intended by the designers to be 64,000 cu. ft. of water delivered per minute against a head of 6 ft.

The wheel of each centrifugal pump was 5 ft. 7 ins. diameter and had four vanes or blades, each being 3 ft. 4 ins. in length measured parallel to the axis. The suction inlet to the pump was a round tube 4 ft. in diameter, connected to a square tube 4 × 4 ft. on the inside, containing a gate.

The capacity of the centrifugal pumps not being sufficient to keep the Chicago River in the required condition of salubrity, an attempt was made to increase the capacity of the pumping station, and with this object in view a contract was let for removing the centrifugal pumps and substituting "Undulating" or Courtright pumps,** regarding which the contractor guaranteed that, with the expenditure of the same amount of power and with the use of the same engines, the volume of water delivered by each engine would be 25,000 cu. ft. per minute against a head of 6 ft., which would be an increase in capacity of about 9,000 cu. ft., or 56% for each engine. Two cen-

*Abstract of a paper presented at the New York meeting of the American Society of Mechanical Engineers.

†Professor of Experimental Engineering, Cornell University, Ithaca, N. Y.

**An illustrated description of these pumps will be found in our issue of July 27, 1893, p. 70. In our issue of Sept. 14, 1893, p. 205, it was stated that the pumps had been wrecked and were being removed.—Ed. Eng. News.

Table of Efficiences of Pumping Machinery.

No. of test.	No. of engine.	Kind of pump.	Indicated HP.	Revolutions per minute.	Depth over weir.	Delivery head, in feet.	Cubic feet per min.	Work of pumping HP.	Efficiency, engine and pump.	Probable delivered HP.	Work of pumping HP.	Probable efficiency of pump.
1	2	Undulating.....	270.7	41.4	1.405	5.645	10,538	112.9	41.7	243	112.9	45.4
2	2	Centrifugal.....	412.2	100.8	1.925	6.108	15,680	182.1	44.2	371	182.1	49.1
3	2	"	240.6	86.4	1.523	5.80	11,898	131.3	54.5	216.5	131.3	61.1
4	1	"	136.1	70.02	1.064	5.18	6,764	66.8	49.1	122.5	66.8	54.4
5	1	"	72.1	56.01	0.320	4.41	1,421	11.9	16.5	64.9	11.9	18.4
6	2	"	344.6	99.7	1.824	5.98	14,969	170.8	51.2	310.2	170.8	55.2
7	2	"	208.9	84.4	1.416	5.62	10,606	113.5	54.3	188	113.5	60.0
8	1	"	212.9	82.4	1.322	5.37	9,440	96.0	45.3	192	96.0	50.0

trifugal pumps, both of which were attached to engine No. 1, were removed during the winter of 1892 and '93 and two undulating pumps were substituted. The remaining centrifugal pumps were kept in position until the undulating pumps had proved by experiment and use to be as represented.

The undulating pump consists of three rectangular pistons which are so constructed as to have partly a rectilinear and partly an oscillatory motion. This peculiar motion was produced by connecting each rectangular piston to a revolving crank by a perpendicular arm and also joining it with a pivoted connection to a sliding cross-head, arranged to move perpendicularly across the case.

The dimensions of each undulating pump were as follows:

Rectangular section of cast iron case, 4 ft. 3⅜ ins. × 2 ft. 8¼ ins. high. Length of case, 24 ft. Piston, dimensions in horizontal section, 8 ft. ⅝ in. × 4 ft. 3 ins. Length of stroke, 16 ins. Area of clearance space on sides of case, 3.72 sq. ft.

Capacity of single pump calculated from piston displacement when in horizontal position and without allowance for leakage or slip: Per 80 revolutions (one minute), rated capacity, 15,245.6 cu. ft. Per 41.4 revolutions, actual speed, 7,889.2 cu. ft.

Calculated leakage, compared with estimated capacity, 23.9%. Capacity calculated by displacement, 2 undulating pumps at 41.4 revolutions per minute, 15,778 cu. ft. Ditto, corrected by leakage, 12,874.8 cu. ft. Actual water delivered per minute by trial, 41.4 revs., 10,470 cu. ft. Additional loss due to slip, 15.2%. Loss due to slip and leakage, 33.7%. Area of inlet tube, 4 × 4 ft., 16 sq. ft. Depth of water to center of entrance tube, 6 ft. 1 in.

Calculated supply of water to each inlet tube on supposition that pump cannot raise water by suction: When depth = 6 ft., 16,610 cu. ft. per minute. When depth = 3, ft., 11,780 cu. ft. per minute.

Methods of Testing.

In order to test the capacity of the pumps and also to afford a working pressure in accordance with contract specifications, it was deemed necessary to build a weir. The length of the weir on the crest was 29.87 ft.; depth of water back of weir crest, 8.66 ft.; width of canal at level of crest, 59 ft.

A hook gage with its zero set level with the crest of the weir was placed on the right bank, in a box 3 × 3 ft., made of 2-in. plank, sunk in the earth near the shore. A 2-in. pipe admitted the water freely and maintained the same level in the box as existed in the canal.

Since the writer was not able to find records of any calibration of a weir notch of the size of the one constructed for this test, and furthermore, since the conditions of its use were somewhat different from those of which records were to be had, it was deemed advisable and necessary to obtain the coefficients of discharge by a special calibration.

The basin between the weir and engine-house was of considerable extent. The writer decided that by making an accurate survey of this basin and determining the cubic contents for each tenth of a foot above the crest of the weir, it would be possible, by noting the time required for the water to fall a given distance, to compute the coefficient of discharge.

[The methods of computing this coefficient are given at length in the paper.—Ed.]

The formula used was as follows for cases where no velocity of approach is considered:

$$Q = c\ (b - 0.2\ H)\ H^{\frac{3}{2}},$$

and for cases where velocity of approach is considered,

$$Q = c\ (b - 0.2\ H)\ \left[(H + h)^{\frac{3}{2}} - h^{\frac{3}{2}}\right];$$

and in which Q equals discharge in cubic feet per second, b equals length of weir, H equals hook gage reading, h equals head due to velocity at a point where H was measured, c equals coefficient whose value is sought.

The results of the coefficients computed from the observations were plotted, and from the curve the following average values of the coefficient were obtained: From 1.9 to 0.9 ft. head, 3.5305; from 0.9 to 0.8, 3.535; from 0.8 to 0.7, 3.545; from 0.7 to 0.6, 3.560; from 0.6 to 0.5, 3.578; from 0.5 to 0.4, 3.610; from 0.4 to 0.3, 3.661.

During the entire time of the test rod floats were run at distances about four feet apart, measured across the channel. The course of these floats were accurately noted by an observer on the shore with a transit, and the observations were reduced by use of Francis' formula.

The formula for mean velocity is as follows:

$$V_m = V_r \left(1.0116 - 0.116 \sqrt{\frac{d - I}{d}}\right),$$

in which

V_r = observed velocity. d = depth.

V_m = mean velocity. I = immersion of rod.

On a diagram of the cross section of the canal the mean velocity and discharge, as computed for each observation, were plotted to a suitable scale. The integration of the curve drawn through the points thus obtained gave the total discharge correspondnig to the observation.

The results as calculated by the formula for the discharge, using rod floats, was 2.7% less than that obtained with the coefficient of the calibration.

Efficiencies of the Pumping Machinery.

The amount of water pumped and the efficiency of the different pumps used at the station is given in the accompanying table. The tests which were made show the indicated horse-power for each engine, corresponding to different delivery heads and different volumes of water discharged. The work of raising the water against the head for the stated conditions was computed, from which the efficiency of the entire plant, including both engine and pump, was calculated. The friction of the engine could not be determined under the conditions existing at

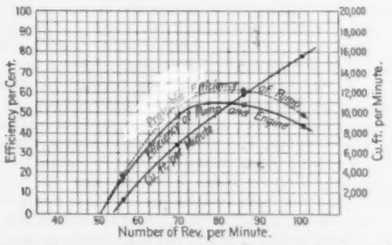

Efficiency per Cent.
Cu. ft. per Minute.
Number of Rev. per Minute.
Pumps Driven by Compound Engine
Efficiency of Pumps and Engine
Capacity of Pumps

Diagram Showing Efficiency and Capacity of Two Centrifugal Pumps, Driven by Compound Engine at the Bridgeport Pumping Station, Chicago.

the time the test was made, so that the efficiency of the pump alone could not be computed without a hypothetical allowance for friction. On the supposition that the engine friction is 10% of the indicated horse power, an amount which is known to be very little in error, a table of probable efficiency of the pumps independent of the engine was computed and is given. The curves of efficiency and capacity of the pumps operated by engine No. 2 are shown in the accompanying diagram.

THE PRESENT CONDITION OF THE UNITED STATES NAVY.

The Annual Report of the Chief of the Bureau of Construction and Repair for the fiscal year ending June 30, 1897, recently issued in the form of a pamphlet of 75 pages and 4 folding plates, contains an interesting statement of the condition of all the vessels in the Navy, including those now building. The total number of vessels of all classes is now 141. Of these there are 9 first-class and 2 second-class battle-ships, 2 armored cruisers, 1 armored ram, 6 double-turreted and 13 single-turreted monitors, 13 protected and 3 unprotected cruisers, and 92 smaller vessels of various kinds, of which 14 are old wooden vessels unfit for service. The report shows a fair degree of progress in the completion of the new vessels, but the work is being prosecuted with much less rapidity than it was for a few years previously, owing to the diminished appropriations and to the refusal of Congress to authorize new contracts for armor plate at prices which would be accepted by the manufacturers. Lack of funds has caused a considerable amount of authorized work to be suspended, and the probable exhaustion of the appropriations before July 1 will make necessary wholesale reductions in the navy yard forces and the discharge of competent and trained men. The Bureau recommends that at least one new vessel should be kept under construction at each of the important navy yards, so that there can always be new work for the yard force to fall back upon when there is a scarcity of repair work. The most desirable kind of vessel to be built in the present state of the armor plate question is said to be a sheathed cruiser of comparatively light draft and great coal endurance.

The necessity for additional dry-docks, capable of receiving the largest battle-ships, is strongly urged, as is also the construction of new buildings and equipments at some of the navy yards. An example of the unbusiness-like way in which the Government manages its navy yards is shown in the case of a 150-HP. Corliss engine put up in 1893 to run the machinery of the plating shop at League Island, which has since been kept covered with tallow and burlap for protection from the weather for want of an engine-house estimated to cost $6,800. Two new boilers erected in 1893 are still housed in a temporary wooden shed.

A short discussion of the subject of turret turning gear is given, showing that the latest experiments indicate that electrical gear is superior on the whole to either pneumatic or hydraulic gear. The batle-ships "Kearsarge" and "Kentucky" are to be fitted with electric motors for controlling all operations in the turrets. As this includes 13-in. turrets, with 8-in. turrets superimposed, the test of the electrical system is the most severe that has yet been applied by any government. A contract has been awarded to the Penn Bridge Co., Beaver Falls, Pa., for $50,000, for the construction of the new experimental model tank at the Washington navy yard. The Bureau has advocated its construction for nearly ten years. It is believed that it will be of the greatest value to the general shipbuilding interests of the country as well as to the navy, and it will be the largest and best-equipped model tank in the world.

A SMALL WATER PURIFICATION PLANT AT MILFORD, N. Y.

The means taken to improve the character of the water supply of Milford, N. Y., were simple and interesting. The supply is taken from a small mountain stream, passing by gravity to a reservoir with a capacity of about 200,000 gallons, and thence by gravity to the village. There is a submerged filter bed in the stream and a another filter bed in one end of the reservoir, upward filtration being employed at the reservoir.

The filter bed in the stream was formed by excavating a small area to a hard clay and gravelly bottom, building a submerged dam of rubble masonry in cement at the lower end of the excavation, laying about 150 ft. of 4-in. sewer pipe on the bottom of the excavation, and filling in with gravel 2 ft. over the top of the pipes. There are ten lines of sewer pipe, laid with open joints, and radiating from a well about 5 ft. in diameter, from which an 8-in. cast-iron supply main extends to the reservoir and thence to the village.

The stream here has a fall of 3 ft. per 100, which the engineer calculated was sufficient to keep the filter bed from silting up, he having observed that trout often spawn on sand or gravel kept clean by the flow of a stream. In case any sedimentary matter reaches the collecting drains the grade of these was designed to be sufficient to cause the matter to be carried to the collecting well, from which it could be removed. The engineer states that in a similar collecting system in another part of New York State not enough sand to fill a two-gallon pail was deposited in the well in a year.

The filter bed at the reservoir is 7 × 20 ft., being formed by a division wall lower than the main reservoir walls. The filter bed rests on a false bottom and is 5 ft. deep. It is composed of five layers of gravel and sand, diminishing in size from the bottom upwards. As already stated, upward filtration is employed. Four lift-gates are provided, by means of which the operations of the filter may be controlled, or it may be thrown out of use, either for washing, or to allow a direct supply from the collecting filter bed. In washing, the flow is reversed, the wash water passing downwards, carrying with it matter lodged in the filtering material. The filtered water passes over the division wall into the reservoir. The reservoir is about 20 × 80 ft. × 8½ ft. deep, and is covered.

Mr. J. Warren Lamb, of Cooperstown, N. Y., was the engineer for the Milford Water-Works system, and we are indebted to him for the information given. The water-works were built by the village in 1893. In 1896 there were 120 taps and services connected with the works.

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ADVERTISING RATES: 20 cents per line. Want notices, special rates, see page 48. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

A most notable event in the annals of American engineering was the formal opening, on Wednesday of last week, of the beautiful new house of the American Society of Civil Engineers, on West 57th St., New York city. In another column of this issue we have given some account of the exercises with which this building was dedicated to its uses, but type and paper are inadequate to convey to our readers the exceeding interest of the occasion, the eloquence with which the distinguished speakers who addressed the audience lauded the engineer and his achievements, or the admiration expressed by the guests for the Society's new and luxurious house. This journal heartily joins in the congratulations to the Society and its officers upon the acquirement of a building in every way worthy of this oldest of our national engineering societies. We venture to join also in the wish, expressed at the dedication exercises, that the possession of this new house may mark the beginning of an era in the Society's history of still larger and greater services to the profession.

The announcement by Commissioner Collis that the new water mains are so far completed that the old distributing reservoir at 42nd St. is no longer needed, marks an event in the local history of New York. It means the speedy passing away of what has been one of the landmarks of this city for nearly two generations. When this reservoir, with its massive stone walls and Egyptian architecture, was finished in 1842, Murray Hill was out in the country, far remote from the then built up portions of the city. With the building of this reservoir and of the Croton Aqueduct, of which it was the terminal, are associated the names of James B. Jervis, Horatio Allen, Major Douglas, and others famed in the annals of American civil engineers. This water supply cost over $12,000,000; and when it is recalled that the city which voted and expended this sum only contained 280,000 souls, it is little wonder that the speakers, at its official opening, on Oct. 14, 1842, proudly classed the Croton Aqueduct with the monumental achievements of the Roman builders of aqueducts. Though eminently useful in its day, this reservoir was never beautiful, even after some of its stone was masked by a generous growth of ivy; and it is now out of place in the heart of a busy city. Its removal will add about four acres to the adjoining Bryant Park, and when the promised New York Public Library is erected upon this site the people of New York can congratulate themselves upon the change, and console themselves with the thought that, while they will miss a familiar landmark, its place will be occupied by a far nobler structure and one of even greater material benefit.

The paper which we print on another page describing a plant for purifying water for use in locomotive boilers is an interesting contribution to an exceedingly difficult problem. No one who is familiar with the various evils that result from scale-forming impurities in the water supplied to locomotive boilers will question that it would be worth a great deal to railway companies if these impurities could be removed before the water is delivered to the locomotives. Within the past few years several Western railways which suffer most seriously from bad water have been experimenting with methods of purification, and one of the most recent is that recorded by Mr. Stillman. It is a noteworthy fact that despite all the experiments which have been made, no railway company has ever adopted the system of water-tank purification for general use. The reasons for this are numerous. One is that the impurities in water from different sources vary so much that different chemical treatment must be given at each place. Another is that variations in the quality of water from the same source at different times makes it almost necessary to have men in charge of the water station competent to make certain chemical tests. Still another is that even under the most perfect conditions, the "purified" water still contains a large proportion of its original impurities. In the case of the water treated by Mr. Stillman, for example, the "purified" water still contains about one-fourth the scale-forming solids of the raw water, and solids which do not form scale are nearly three times as great in volume.

Under these circumstances, it is not at all strange that the railway manager finds it hard to discover a commercial profit in water-tank purification. The whole system of blowing-off boilers, cleaning out scale, washing out at frequent intervals, etc., must still be maintained, even if every water-tank on a system were equipped with chemical purifying tanks, and it would be difficult, we fear, to compute a saving from chemical purification that would equal the cost of its installation and operation.

The fact appears to be from all the experience at present available, that, with the possible exception of certain local cases, the most economical place to purify water for locomotive use is in the locomotive boiler. Some of the solid ingredients in the water are bound to be deposited there anyway. With a good boiler purge prepared by a competent chemist to suit the especial water to be treated, it is quite possible to reduce the accumulation of scale on tubes and sheets to a reasonable amount, and surface and bottom blow-offs properly used will take care of the scum and mud.

With stationary boiler plants, on the other hand, it is probable that the advantages from purifying water before feeding it to the boiler are far too little appreciated. It should be possible to operate a water purifying plant in connection with a battery of stationary boilers at a trifling cost for attendance, and as heat can be made use of in the purification, much more complete removal of scale-forming ingredients can be had than at a locomotive water supply station. Our remarks in the preceding note, therefore, should not be construed as in any way applicable to the water supply plants for stationary boilers.

Automatic signals formed the subject for discussion at the meeting of the Railway Signaling Club, in Chicago, on Nov. 16, and while the discussion did not bring out anything particularly new respecting the respective merits of the manual and automatic systems, it did present pretty concisely both sides of the subject. On the one hand it is claimed that automatic signals are equally as reliable as manual signals, besides being cheaper to instal and less expensive in operation. In fact, it is stated that in cases where block sections have been made very long, on account of the cost of installing and operating the manual signals, it would be cheaper to use automatic signals and short block signals, thus facilitating the movement of trains. On the other hand it is claimed that it is desirable to have human brains and intelligence in control of the signals, and that enginemen are very apt to disregard signals when endeavoring to make up lost time if there is no operator to see and report upon such action. While this objection is not aimed at the automatic signal in itself, the signal doing its duty in indicating "stop," it does strike at the system of using such signals, as this disregard for signal indications may be a serious element of danger. Advocates of automatic signals are apt to make light of this, and claim that it puts a low estimate on the character of the enginemen, but the fact seems to be that these men will and do disobey such signals when it suits their ends. This is especially the case if the signals are far away from stations or towns. The necessary practice of allowing an engineman, stopped by an automatic signal at danger, to proceed if the signal does not clear in a few minutes, also tends to induce negligence and disobedience on the part of the enginemen, and practically introduces permissive blocking, with its objectionable features. Failures of automatic signals are pretty freely talked of by the advocates of manual signals, but the advocates of automatic signals point out, with some force, that very often these signals and their connections are given very little attention, and that if reasonable care is taken to keep them in good condition, there will be little trouble of this kind. It is rather curious that little was said in the discussion as to the respective merits of disk and semaphore signals, although the author of the paper which opened the discussion strongly advocated the latter and described a new form of automatic electric semaphore which is now in operation, and which is in form exactly similar to the ordinary manual semaphore. The desirability of having a uniform type of signal is so widely recognized that an efficient automatic semaphore signal of low cost is likely to be a very powerful rival of the automatic disk signals now in use.

The proper division of the cost of public water supplies between private and public consumers is a matter that hitherto has received too little attention. Where water is supplied by private companies some division of this expense is generally made, but under municipal ownership it frequently happens that the rates are designed to make the private consumers pay the whole expense of maintaining the works, although often, through miscalculation or poor management, a deficiency arises that must be met from the general tax levy. A number of cities owning water-works do allow their water departments something for water used for fire protection and other public purposes, but the allowance is likely to be a hap-hazard one, with a strong tendency to make it too low. It has long been common for pressure to be brought to bear upon city officials to give manufacturers and other large water users low rates, and there is in many communities a tendency to keep lowering household rates in order to gain popularity for the administration or some of its members. Within the past few years quite a strong sentiment has developed for so-called "free water," or the putting of the whole expense of the water-works into the annual tax levy, instead of attempting to make each family pay for what it uses, or is supposed to use. This is partly a reaction from high water rates to private consumers, due to a failure to divide the burden between them and the taxpayers as a whole, and partly a result of actual and proposed extensions of the meter system. In many cities, especially where a heavy waste of water causes a high per capita consumption, all proposals to cut down the waste by introducing or extending the use of meters, are likely to be met with the plaintive cry that "water should be as free as air." Those responsible for water-works management are well aware of the fallacy of this claim, knowing far too well what it costs to make water as available as is the air. Just now the water department of Buffalo is considering how it can meet the demand for lower rates in that city. Buffalo has for some time had a very low meter rate, selling water in large quantities for

3 cts. per 1,000 gallons, its highest meter rate being 6 cts., and its fixture rates being rather low.

It is now reported that the Buffalo water department expects to lower its private rates still further, more especially those to small consumers. This the department expects to be able to do by charging for water used for public purposes, and also through the economy effected by improvements to the plant.

The equitable division of water-works expenses between the general public and the private consumers is a question demanding careful consideration, and one that must be adjusted to local conditions. Obviously each beneficiary should pay that part of the total expenses for water that is incurred on his behalf. To this end the cost of public and private service should be determined and the total amount in each of these classes properly distributed among the several members. For convenience the whole of the cost of public service may be lumped together with the other charges upon the municipality as a whole, or it may be distributed among the departments of fire, streets, sewers, justice and education. There are strong reasons for showing on the books, if nothing more, just what it costs to furnish each department with water. Besides this, if each department were debited with the water used by it, water waste in many cities would be greatly reduced. We shall look forward with interest to the solution of this problem that may be reached in Buffalo.

Our attention has been called to the fact that the diagram published on p. 292 of our issue of Nov. 4 for determining the size of beams of rectangular cross-section is practically identical with Diagram No. 8a in "Crehore's Tables and Diagrams." The author of the article, however, writes us that he had never happened to see a copy of Mr. Crehore's book, and the diagram in question was computed and plotted by him in June, 1894. If the publication of this diagram shall in any way serve to call our readers' attention to the very useful collection of such diagrams which Mr. Crehore has developed, it will be well worth the space that it occupied.

WIDENING THE GAGE OF RAILWAY TRACK ON CURVES.

Notwithstanding the very general practice of widening the gage of railway track on curves, there is nowhere, so far as we know, in any of the more familiar manuals of railway engineering, a clear statement of the principle upon which this practice is based or of a working method of applying the principle in actual track work. In some of the larger treatises, and notably in Wellington's "Economic Theory of Railway Location," the mechanics of truck action on curves are very fully discussed, but here, as in the smaller field books, the special application of the theory to the widening of gage on curves is nowhere mentioned. This very general neglect of engineering writers to consider this problem of curve construction makes the paper by Mr. Wm. H. Searles, M. Am. Soc. C. E., which we publish elsewhere in this issue, of especial interest. Besides presenting the mechanical reasons for widening the gage the paper gives a number of simple formulas for calculating any special case which may occur in ordinary practice, thus adapting the discussion directly to the needs of actual track work.

The subject discussed by Mr. Searles has been made prominent recently by the investigation of the American Railway Association's Committee on Standard Wheel and Track Gages, the results of which were published in our issue of Oct 14, 1897. This investigation showed that a considerable number of railways, including several well known for the excellence of their track construction, had abandoned or else had never adopted the practice of widening the gage on curves. On the other hand, a number of railways widen curves as flat even as 1°, although hardly any two railways use the same rule for widening. A more significant feature of the report, however, was not only the great variety of practice that exists, but the fact that the ideas of railway managers regarding the reasons for widening the gage are as diverse as their practice.

In his paper published in this issue Mr. Searles shows that the widening of gage on curves is a simple question of mechanics, which can be solved with mathematical exactness, and which, when properly understood, offers no opportunity for diverse theories or practice.

The problem before us in any particular case, as Mr. Searles points out, is a question of ratio between the degree of curvature and the length of locomotive wheel base, modified by the amount of clearance between wheel gage and track gage and by the amount of side motion provided for at the centre pin of the locomotive truck. Theoretically, at least, all these are known or measurable quantities and their numerical values are easily inserted in a general formula.

Of course in practice a certain amount of variation exists, due to unequal mounting of wheels, wear of flanges, carelessness in spiking rails and placing rail braces, and to wear of the swing motion and other parts of the trucks. Most of these, however, operate to reduce the necessity for widening the gage on curves.

It is not difficult, we believe, to account for the fact that so many railways follow the practice of widening gage even on very flat curves. The behavior of a truck in rounding a curve is a subject on which erroneous ideas are very generally held, even by engineers; and the idea that the track must be "eased" at curves to save rail wear and reduce the tendency of the rail to roll outward has such a firm hold upon the "practical" men in charge of track repair, that railway officers have been inclined to accept this view of the matter, especially as trouble seldom arises from such widening of the gage as is usually done, and if a derailment does occur, some other cause than the right one is given.

Besides this, it is quite possible that in the early days of railway operation, when uniformity in track gage, wheel gage and truck play was far from being attained, there may have been greater need for widening the gage on curves than at present.

Be this as it may, the important point to which we wish to call attention is that the replies to the Association committees question: "What is your guiding reason for widening gage on curves?" show that many railway officers need to give more careful attention to this matter. When an officer who widens the gage on a 1° curve states that he does it to reduce rail wear we wonder how he has reached the conclusion that the wear of rails on an easy curve is at all affected by widening the gage.

That there is no sound reason for widening the gage on very flat curves, most engineers will admit, we think, after studying Mr. Searles' clear statement of the problem. Both the mechanics of truck action on curves and the experience of the important railways which do not widen the gage on flat curves seem to prove this very clearly.

But when we come to the question of widening the gage on sharp curves, it seems to be equally clear that it should be done. It is true that some of the answers to the Railway Association Committee's question seemed to indicate the contrary, but this appears to have been due to the fact that some of these answers were so brief as not fully to state the case.

In order to determine this beyond dispute we made direct inquiry concerning the actual conditions on a number of the most important railways which reported no widening of gage on curves to the Association's committee. Three of the replies to this inquiry we publish here, as they bring out a number of factors in the general problem of widening gage on curves which need to be understood; but the fact in question is shown just as clearly by the other replies which we received in response to our inquiries.

Sir: The statement that our road no longer widens the gage of track at curves is true only up to certain limits of curvature. The sharpest curve on our main line is 4° 30′, and we lay that and all other curves in our main line to standard gage, but on all curves of 6° and over in industrial and inferior tracks, we widen the gage to a degree dependent on the radius of the curve. It is doubtless true that the relation of the wheel gage to the rail gage is not exactly preserved in curves of any radius without departure from the standard gage in laying the rail, but the difference is slight and the objection to providing for it is that an unusual, and as we believe an unnecessary amount of care devolves upon the track foreman to secure just the right widening of gage to fit the various main line curves on his section. The use of transition curves, which is universal on this system, would make an exact adjustment of the widening which is theoretically required, a still more complex duty for the trackmen, and our experience, which was gained by observation of the bahavior of the sharpest curves, seems to us to have proved that the securing of absolutely equal gage throughout the curve was far more beneficial than trying to reach the theoretical adjustment of gage by any means we had at hand. Observation has failed to disclose to the officers in charge of track on this road that there is any less flange wear under equal conditions with the gage laid wide and with the gage laid to the standard width. We do not on this road move the rails to bring them back to exact gage if the gage has apparently been widened by abrasion from the outer rail, but when the inner, or the outer, or both rails, have rolled to any aprpeciable degree, we square them up and bring the inside faces to the standard gage distance apart. It would seem to us that the widening theoretically applicable to the curves of larger radius was too hard to accomplish for the practical results which would be secured.

Yours truly,

A. Torrey,

Chief Engineer Michigan Central R. R.

Detroit, Mich., Oct. 21, 1897.

Sir: That you may better understand our situation, I will say that our gage is in a transition stage. For many years 4 ft. 9 ins. was the standard gage, but for a few years past, in laying new rail on straight line, the gage has been changed to 4 ft. 8½ ins.; but on most of our curves the gage remains 4 ft. 9 ins., so that on curves which do not exceed 8° we have not increased the gage. We have one 19° curve in our main track, at a terminal point, over which all passenger and freight traffic is moved, on which the gage has been widened to 4 ft. 9½ ins. On side tracks of short radii we have found it necessary to widen gage to allow long wheel bases to pass around curves more freely. One division of our system has side track curves from 19° to 28° laid to 4 ft. 9¼ ins., and finds them satisfactory. This question of the proper gage on curves of different radii is before our Association of Transportation Officers, and we have not yet arrived at final conclusion as to what should be our future practice. A table prepared last September indicates that we have 1,872 miles of line laid to 4 ft. 9 ins. gage and 1,159 miles laid to 4 ft. 8½ ins. gage.

Yours truly,

Thos. Rodd,

Chief Engr. Pennsylvania Lines West of Pittsburg.

Pittsburg, Pa., Nov. 17, 1897.

Sir: I have delayed answering your letter in regard to close gage of track on curves, for the reason that we have not reached definite conclusions. It is essential to demonstrate by actual experience the correctness, or otherwise, of the idea. As is the case with many other mechanical problems, experience is the desirable guide towards methods different from those in general use.

I thought many years ago that as the standard wheel gage, when compared with the standard track gage, permits end play of ⅝-in. between points of contact of flange of wheel and wearing point of average form of rail, that it was sufficient for the usual curves on average standard gage lines.

The Denver & Rio Grande R. R. has a large per cent of curvature, the maximum being on standard gage about 12°, although there is but very little of this. I am aware that on a 12° curve, spiked to gage, the flanges strongly crowd the rail with the rigid wheel-base of our Consolidation and Ten-wheeled types of engines, and perhaps measurably with the wheel-base of six-wheeled passenger car trucks where it is longer than the usual standards.

Two and a half years ago we had some of our sharpest standard gage curves spiked to gage, and the majority of curves of 6° and under treated in the same way. By recent examination we find, taking the average of three 12° curves, two 7° and one 6°, that they are from ⅛-in. to ¾-in. wide to gage, without taking into consideration the amount sheared by the wheels from the inside of the head of the rail. I think the shearing of the rail on the 12° curves has been more than is economical and desirable during the period named.

It is proper to state that we feel satisfied that our passenger trains ride steadier on curves that are close to gage than they do on those that are not. One of our most experienced officers and a most efficient and excellent trackman, says under date of Oct. 29, in reply to an inquiry addressed to him: "All tracks, curves, tangents, switchleads, or any other place on a railway should be put to gage. If the machinery and rolling stock of this or any other railway is built for a 4 ft. 8½ in. gage and kept in proper repair, there will be no trouble experienced on account of gage." His opinion is entitled to serious consideration because of his long years of practical experience and his close observation in all matters pertaining to track. We will be in a better position to express ourselves definitely one or two years from now on this important subject than we are to-day.

Yours very truly,

E. T. Jeffery,

Pres. and Gen. Mgr. Denver & Rio Grande R. R.

Denver, Colo., Nov. 9, 1897.

Several of the statements made in these letters will repay a little further study. It was mentioned above that no very obvious harm resulted when we widened the gage of flat curves slightly, even if the dimensions of the wheel base used did not call theoretically for more than the regular flange clearance. The fact that a disadvantage is not clearly obvious, of course, does not mean that no disadvantage exists; indeed, a material injury results, as Mr. Torrey points out in his letter, through putting unnecessary work upon the trackmen if in no other way. The care necessary to keep the gage of track in perfect condition under favorable conditions is too well known to make it necessary to insist further that any needless complication of the work should always be avoided.

The fact pointed out by Mr. Searles that the locomotive wheel base and the motion of its front truck is ordinarily the factor that determines how sharp a curve can be left without widening is one of much importance. It points directly to the need for more intelligent design in locomotive running gear to suit it to the track on which it has to run. It raises the question whether the side motion of the truck should not be much less on locomotives built for roads of easy curvature and increased on locomotives for use on roads with sharp curves. At present we know of no railway which has established standards for the side play of its locomotive trucks; it is a matter left to the judgment of the mechanical department, and as a consequence on most railways the locomotives of various ages have a truck motion corresponding to the peculiar ideas of whatever master mechanic happened to be in charge when the locomotive was built.

LETTERS TO THE EDITOR.

The Difference Between a Cantilever and a Suspension Bridge.

Sir: In your issue of Oct. 21 you cite a case (the Elbe Bridge at Loschwitz, Saxony), in which you express doubt as to the type of this structure and ask, "Can any essential feature of either structure (cantilever or suspension bridge) be laid down which will determine where this bridge belongs?" I beg leave to submit the following: The term cantilever implies a lever in which equilibrium is established by anchoring down or counterweighting one arm (the lighter) of a lever to counterbalance the other arm. This would imply that a load, dead or alive, when applied to a cantilever arm, shall produce no stresses in any portion of a structure in its entirety, except in the loaded arm and its counter or anchor-arm. Any structure in which this is not the case will not be a cantilever. The manner or method of erection has no bearing on the classification of bridges, and it is common to erect arches, suspension bridges and even plain trusses after the method of erecting a cantilever, and such structures are cantilevers up to the instant of closing and removing temporary erection members. In the case under discussion (Elbe Bridge) a load on any portion of the span will produce stresses over the entire span and on both abutment supports, therefore this bridge cannot be a cantilever, and from its properties must be classed as a braced suspension bridge.

Very respectfully, David Molitor.

41 Telephone Building,
Detroit, Mich., Nov. 8, 1897.

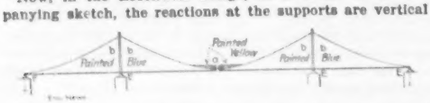
The Loschwitz Bridge a Cantilever Structure.

Sir: In your issue of Oct. 21 you put the following question to your readers:

What is the difference between a suspension and a cantilever bridge, and especially to which class does the Loschwitz bridge belong?

I think that the essential features of a suspension bridge are that it is suspended by cables or chains. Therefore, in the chords, which act as cables or chains, there must be a horizontal pull transmitted through the whole length of that chord, which must be taken by the anchorages. Furthermore, the advantage of a suspension bridge is that the erection is effected by its cables and the whole dead load is carried by them alone.

Now, in the Loschwitz bridge, as seen in the accompanying sketch, the reactions at the supports are vertical



only, and the system is interrupted at the center of the middle span by a construction which acts like a pin connection. Thus no horizontal pull can be transmitted through the upper chord, although its form is that of a catenary curve.

The designers of the bridge, for the purpose of giving the observer the impression that the bridge is a suspension structure, have painted the part above the catenary curve yellow, while the rest of the bridge is painted blue.

The bridge was erected by rigid falsework under all three spans. Therefore it seems to me that the Loschwitz bridge is a continuous girder with a hinge in the middle span, and that it should be considered a cantilever structure.

In conclusion, I might say that the bridge is not considered a good example of bridge design in Germany, either by architects or engineers. It is jokingly called "the blue wonder." H. Reissner.

New York city, Nov. 22, 1897.

The Design of a Floor Beam with a Combined Plate and Lattice Construction.

Sir: In your issue of July 8 there appeared some standard details of bridges, as described by Mr. Hilgard, Engineer of Bridges, N. Pac. R. R. Among other uncommon details a floorbeam is shown which, for multiplicity of parts, cannot easily be surpassed. The writer's attention was especially directed to this construction by recently seeing in the shops of a large bridge company a floorbeam, similar to the one mentioned, in the course of manufacture, and hearing the uncomplimentary remarks which it drew forth from the men handling it. Closer investigation revealed the following facts which might be of interest to your readers: The central portion of the floorbeam, 4 ft. 6 ins. deep and 5 ft. 9 ins. long, is left out and replaced by a pair of "poor man's suspenders" with the necessary patches, large in number and trying to the temper of the shopmen. Instead of a continuous web there are two end plates and only 20 additional pieces, fit for the scrap heap. These 20 pieces require 130 punched holes, 38 reamed holes and 38 rivets, with the milling of 22 ends over and above what would be required for a continuous web, all of which is accomplished at a loss of 70 lbs. of metal, for the full web weighs 70 lbs. less than the lattice work with its necessary complication.

Where is the philosophy of this? If the 20 pieces riveted together could be made stronger than one continuous piece, then the floorbeam cut to pieces and patched up again is stronger than one of the usual construction. The less said about appearance the better; at first sight one is strongly reminded of the discarded targets seen at Uncle Sam's proving grounds. Attention ought to be called to this matter because it has been stated that in general this kind of design (partial plate and lattice) is not only not more expensive, but, on the contrary, cheaper than a full web plate girder. It requires more than ordinary courage to make that statement in a paper so widely read as yours. In the present depressed state of business a bridge manufacturer might make any statement in order to secure work; but upon closer examination it will often be found that such statements are worth nothing, as shown in the present instance. Yours truly,

Henry Szlapka.

761 East State St., Trenton, N. J., Aug. 10, 1897.

(We sent a proof of the above communication to Mr. Hilgard, but by a mischance it did not reach him till very recently. We append his reply, as follows:—Ed.)

Sir: I regret that owing to my absence, during most of which I was beyond reach by mail, Mr. Szlapka's letter did not come to my notice any sooner. All my own records being packed and stored, I cannot enter into details, but will gladly submit the following: I may remark in the first place that Mr. Szlapka's criticism is one-sided on account of his considering the matter from the manufacturer's standpoint only.

As to the open floorbeam, no claim was ever made by me that it was lighter or cheaper for the same strength than a closed "full web" floorbeam, nor that it was stronger for the same weight or cost. Such a claim would be absurd.

Furthermore, the critic claims 20 additional pieces for an open floorbeam, while there are actually but 13, and each being in its proper place. The extra cost to the Ry. Co. of such a floorbeam, as shown on the inset in your issue of July 8, amounts to very little compared with the advantage gained. The design was adopted some time ago in preference to the former and more usual "full web" floorbeam in order to facilitate manipulation during erection, but especially inspection, by permitting the inspector to pass easily through the entire space below the floor. Experience showed that the most thorough inspection (first and annual) obtained is that which is easiest to accomplish. Under conditions as they exist on the Northern Pacific Ry., at least, the additional price knowingly paid for this style of floorbeam is considered well justified. The claim of economy to the Northern Pacific Ry. Co. was and is made, however, for the "plate-lattice" designs for the main girders of the spans for which they were adopted, viz., 85 to 105 ft.

In 1895 and 1896 complete detail plans for "full plate" and for "plate-lattice" girders for five 100-ft. spans, four-deck and one through, were submitted to twelve to fifteen of the larger bridge shops. The majority of bids, including the lowest bidders, showed either no difference in the prices per pound of metal in the finished superstructure, or else but such a slight advance in price for the "plate-lattice" girders as not to offset all saving in weight effected. In 1897 two large Eastern bridge shops, both near Philadelphia, and both of which have built a number of either lattice or "plate" and "plate lattice" girders for the Northern Pacific Ry., under the present specifications, bid the lowest price per pound on deck spans of the last-named type, although they were both underbid by other shops ranking also among the best, whose moderate prices for the creditable work which they furnish will still leave a handsome margin below the formerly estimated average cost per pound of finished "Northern Pacific" superstructures for 1897, and quoted in your issue of July 15, on the basis of all contracts since let and in part completed. Respectfully yours,

K. E. Hilgard, Consulting Engr.

St. Paul, Minn., Nov. 16, 1897.

Calculations of Sinking Funds.

Sir: The article by Peter Mogensen on the calculation of the sinking fund in Engineering News, of Oct. 21, was read with interest. His formula $\frac{A}{C} = \frac{r^2-1}{r^{2n}-1}$, gives somewhat different results from that quoted by Kuichling on p. 206 of the proceedings of the Am. Soc. C. E. for April, 1897. The latter formula is

$$S = \frac{r}{(100+r)\left[\left(1+\frac{r}{100}\right)^n - 1\right]},$$

calling the factor "p" unity.

Again, both of these formulae give different results from the data given by Kiersted on p. 158 of the proceedings of the Am. Soc. C. E. for March, 1897.

For example, it is desirable to know the sinking fund necessary to liquidate $1,000 in 20 years, the fund to be invested annually at 6%. The results by the three authorities are as follows, viz.:

Kuichling	$25.65
Mogensen	26.00
Kiersted	27.18

It will be observed that the second is nearly 5% and the third is about 6% more than the first. When it is necessary to provide a sinking fund for a large amount of bonds it is quite important to know which is correct.

Will you kindly state which figure is correct and verify or publish the proper formula. Respectfully,

P. H. B.

Cheyenne, Wyo., Nov. 10, 1897.

(We have verified the several formulae as requested by our correspondent, and find that they are all correct, the differences between them being due to differences in the given problems. In order that the matter may be clearly understood, we restate the problems below.

Mr. Mogensen's formula:

$$\frac{A}{C} = \frac{r^2-1}{r^{2n}-1}$$

A = annual installment, the first payable one year after the investment, and the last at the end of n years, C = capital invested; r = $1 with one-half year's interest added; n = number of years from the investment to the maturity of the sinking fund, when the latter is equal to the capital invested. The installments are put at compound interest, payable semi-annually.

Mr. Kiersted's data are: At 6% interest the annual contribution to the sinking fund would be $27.18 to make the fund equal $1,000 in 20 years. The formula is not given, but the installment, $27.18, agrees with that given by Mr. John W. Hill in a table in Engineering News of Jan. 25, 1894, and reprinted in Kent's "Mechanical Engineer's Pocket Book," p. 16. It also agrees with the result of a computation by the following formula given in p. 15 of the "Pocket Book."

The annuity, which would amount to $1 in n years, is

$$\frac{i}{(1+i)^n - 1}$$

in which i is the interest on $1 for a year. The same formula is given in the "Encyclopaedia Britanica," article "Annuities." This formula assumes that the interest is compounded annually, and that the first installment is paid at the end of the first year.

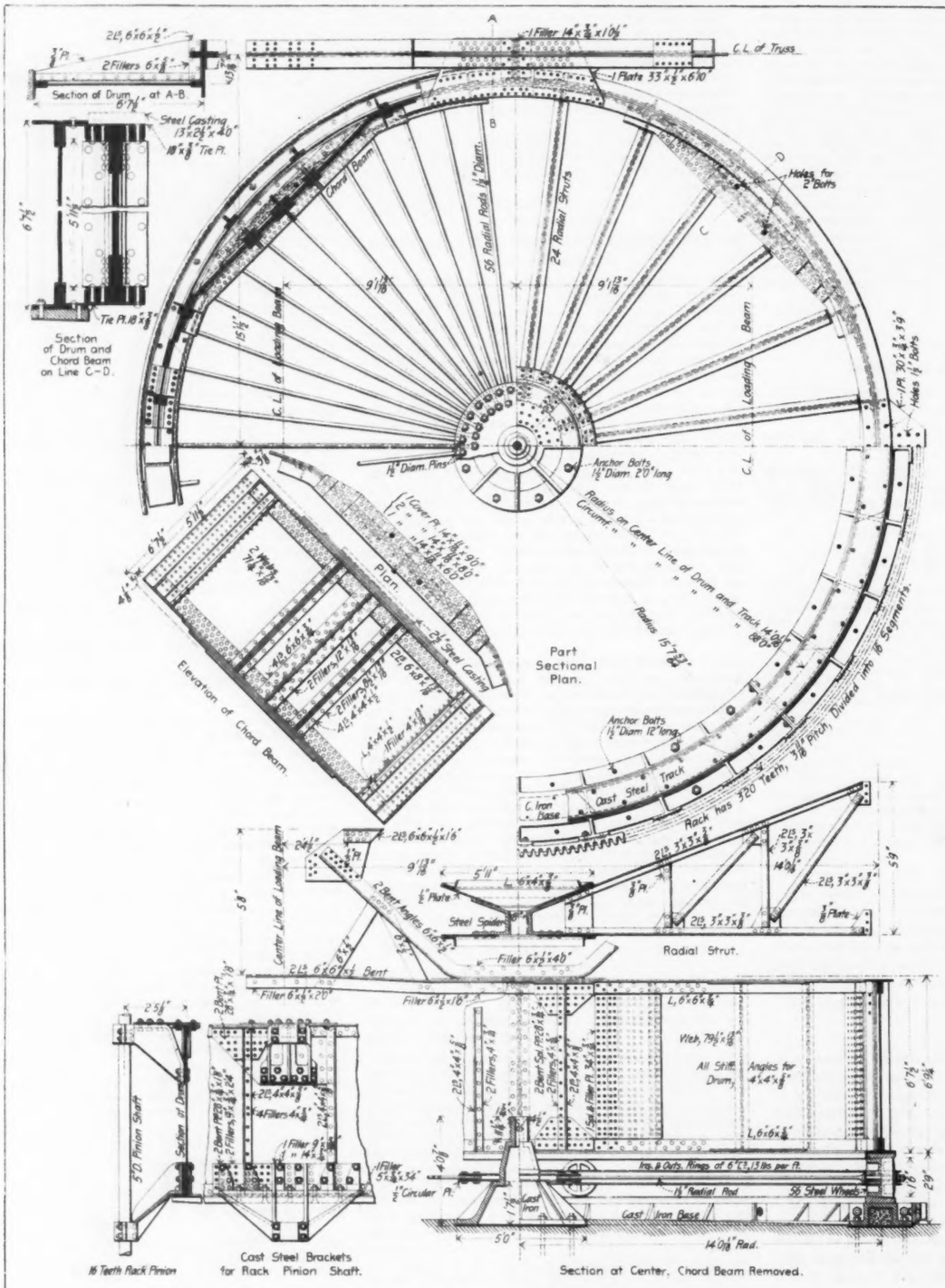


FIG. 12. DETAILS OF TURNTABLE.

DRAWBRIDGE OVER THE CHICAGO DRAINAGE CANAL; CHICAGO, MADISON & NORTHERN RY.

Isham Randolph, Chief Engineer Sanitary District of Chicago.
David Sloan, Chief Engineer C. M. & N. Ry.

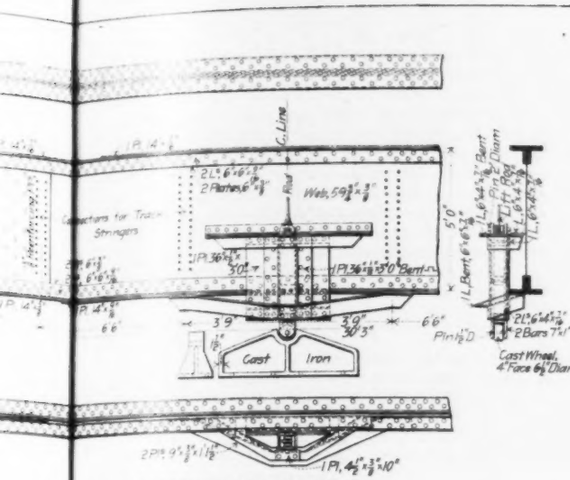


FIG. 9. END FLOORBEAM, SHOWING LATCH.

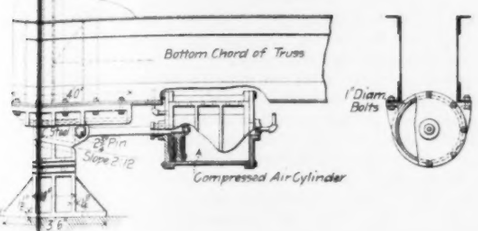


FIG. 11. DETAILS OF END LIFT.

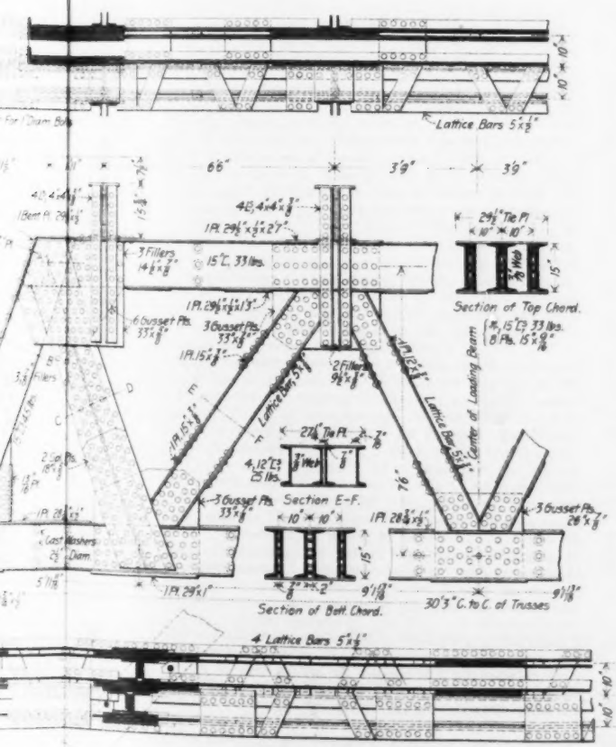


FIG. 7. DETAILS OF LOADING BEAM.

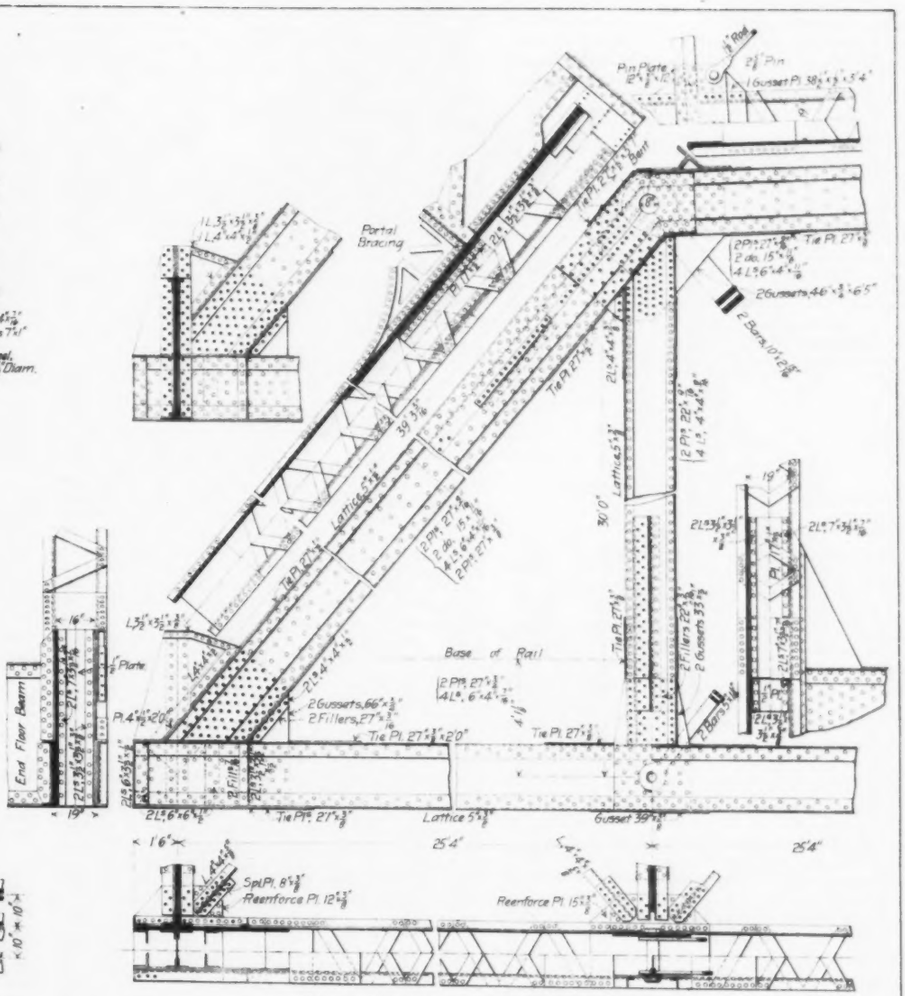


FIG. 5. DETAILS OF END PANELS OF TRUSS.

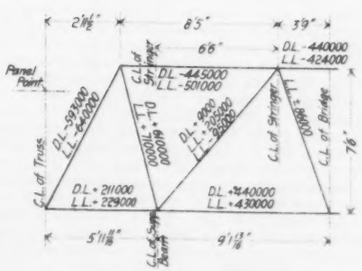


FIG. 8.
DIAGRAM OF STRESSES
OF LOADING BEAM.

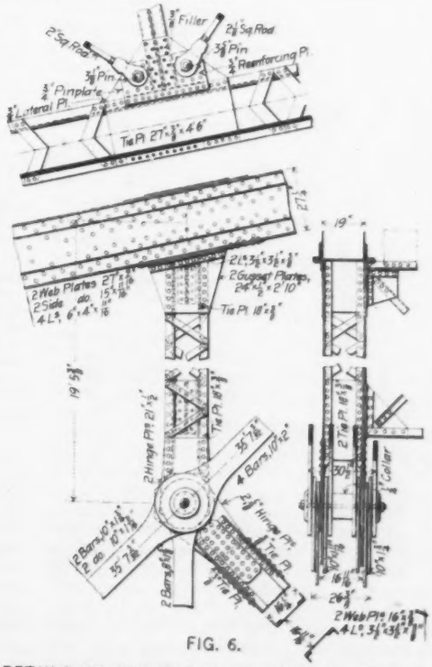


FIG. 6.
DETAILS OF CONNECTION AT PANEL POINT "Me."

CHAS. HART & SONS, LITH., 30 VESEY ST., N. Y.

Mr. Kuichling's formula is

$$s = \frac{r}{(100 + r)\left[\left(1 + \frac{r}{100}\right)^n - 1\right]}$$

s being the annual payment, which must be made during a period of n years and invested at compound interest at r % in order to produce a certain ultimate principal. Mr. Kuichling does not give the derivation of the formula, but an arithmetical computation of the result of four annual payments of $1, assuming that the payments are made at the beginning of each year, interest being compounded annually, and running to the end of the fourth year, shows that the formula is correct if based on these assumptions. Also an algebraic summation of the series $(1 + i) + (1 + i)^2 + (1 + i)^3 \ldots + (1 + i)^n$ gives

$$\frac{(1 + i)\left[(1 + i)^n - 1\right]}{i}$$

as the amount of an annuity of $1 for n years, i being the interest on $1 for one year, compounded annually. The reciprocal of this fraction is the annual payment needed to make the fund amount to $1 at the end of n years, and it agrees with Mr. Kuichling's formula after changing the notation, his r being equal to $100 \times i$.

The three formulae are thus shown to rest on three different assumptions, the first supposing that the first installment is paid at the end of the first year, and that interest is compounded semi-annually; the second that the first installment is paid at the end of the first year and that interest is compounded annually; and the third, that the installments are paid at the beginning of each year, and that the interest is compounded annually. The second is the one usually given in annuity tables, but it would appear that the first is more accurate, as sinking funds may ordinarily be invested in bonds on which interest is paid semi-annually. The third case, we think, is a rather uncommon one, for payments into sinking funds are usually made out of yearly profits of a concern at the end of a year, and are not advanced out of the working capital at the beginning of each year.—Ed.)

The Projected Deep Waterway from the Lakes to the Atlantic.

Sir: In the discussion of the ship canal project, printed in your issue of Nov. 11, Major Symons makes his inaccurate quotation of my language, printed in the next column, the basis for a request that I furnish information which a careful reader would not need. Precise information can be found by those desiring it in the proceedings of the American Society of Civil Engineers of 1895, and in those of the International Deep Waterways Association, generally called the "Red Book." The data of cost of transportation I then published were based on the season's balance sheet, still in my possession, of a large fleet of lake steamers. Fogs, storms, winds, shoal water, delays at locks and in port, and all the untoward incidents of lake navigation, affected the performance of this fleet, and removed it from that ideal one which the Major accuses me of relying on in argument.

He thinks four miles per hour a safer estimate of canal speed than seven miles. Seven miles per hour speed was first assumed by Thomas Curtis Clarke, Past-President Am. Soc. C. E., in his discussion and papers on the subject, and I will leave to him its defence. The slower speed changes the percentages slightly, but not the general tenor of my argument, as on this basis the Major's ship would steam 8 days and be idle 14 days per trip; steam 80 days and be idle 285 days per year. Major Symons' and Mr. Clarke's arguments against the ship canal cannot be maintained, unless it be proved that 12 to 15 days are necessary to unload and load a steamship in New York harbor. This assumption of theirs is not based on facts, as any one can prove for himself by reading the marine news and observing the times of arrival and departure of the vessels of any line. It can be shown that cargoes are now handled in New York harbor with a dispatch approaching that obtaining on the lakes, although it is true that all cargoes are not handled with equal dispatch, because the foreign shipmaster sees no sufficient incentive to handle cargoes cheaply when he can make the American customer bear the expense.

The following quotations are apposite: Major Symons' Report, p. 54, "Regarding the time of unloading package freight, one record at this dock is the unloading of 2,515 net tons in 6 hours and 15 minutes."

Foster Crowell, M. Am. Soc. C. E., "Engineering Magazine," Oct. 1897, "The steamship 'New York,' between 8.35 a. m., Nov. 17, and 10 a. m., Nov. 18, at Pier 14, North River, discharged and loaded 6,317 tons, an average of 300 tons per working hour." Further on, in the same article, pp. 19 and 20, he describes the Brown wharf machine for the Pennsylvania R. R., at Pier J, Jersey City, and says: "This machine is expected to revolutionize the handling of material in New York harbor." See also same author's article in "Engineering Magazine" for November.

H. A. Bourne, President Old Dominion Steamship Co:

Steamers of this company are loaded on a regular schedule, and their time in port varies, according to the days of their arrival and departure from here. For instance, the steamer arriving here at 4 o'clock Friday afternoon sails Saturday at 4 p. m. Some other days in the week they are in port 48 hours. The time for discharging and loading depends very much upon the room we have on our pier to distribute the cargoes, and also as to the character of the freight handled. The steamer "Princess Anne," with a bulk capacity of 150,000 ft., can be discharged, coaled and loaded again in 24 hours. This requires, however, that the dock be not choked with freight.

Evidence similar to the above could be cited to the fatigue of the reader, but it is obviously unnecessary.

Sufficient data, which cannot be challenged, are available of the cost of water transportation under a variety of conditions. The Major's valuable report, which adds materially to the stock of information, should be cleared of arithmetical errors. I appreciate the space given in it to my own work, and his proving that there are twenty-four million tons of freight waiting for the ship canal. But such estimates as those put forth in his report merely befog the question. Ships would not limit their operations as he has limited them.

I consider it futile to discuss whether lake steamships can go on the ocean, or whether our coast steamship equipment will adapt itself to improved conditions when all our coasts are accessible to all our ships. The first is a question of organic law, settled by the Supreme Court in its famous decision that the Great Lakes are the high seas. The second is a question of commercial law. Such considerations, while germane, do not vitally affect the principal question, which is whether a deep waterway, with the very best equipment and improvements, on the best possible freight route from the lakes to the ocean, will give us the lowest possible freight rates and the greatest volume of trade; and whether, all things considered, such a waterway will be a profitable investment. Major Symonds' investigation was limited in scope by the act making the appropriation to canal routes entirely within the United States. His conclusion that such a route is undesirable now seems well founded, but the fact that he was prohibited from considering the Champlain route necessarily makes his investigations partial and his deductions inconclusive. The present commission are not fettered by their instructions. Their investigations are intended to be comprehensive. I do not doubt that their conclusion will prove what I have long maintained—that the ship canal can be built and operated profitably, under suitable governmental regulations, as a private enterprise.

Respecting Major Symons' suggested enlargement of the Erie Canal to a depth of 12 ft. for big barges. It is unlikely that any man now living will see such a work begun. The lock lengthening, begun in 1885, is still unfinished, and the nine million-dollar credit for the present enlargement is covered by contracts which will leave one-third of the work untouched, and this despite the ability, economy and hard work of the State Engineer and his staff. Under the most favorable circumstances the 9-ft. improvement now under way cannot be utilized earlier than 1903. Further enlargement thereafter to 12-ft. depth, by the State, is for many years not to be thought of. It is even more unlikely that it would ever be undertaken by the Federal Government. Manufacturing uses of the Erie Canal water exceed in value and profitableness the navigation uses; and those interests would strenuously oppose a change which might shut up the factories. No more water can be spared from the watershed of the central counties. The suggested big barge canal would have to be fed by water brought in steel pipes from Lake Erie. Upon the lines suggested the natural conditions are unfavorable to its construction, and the interference with vested rights would involve enormous expense; but were such a barge canal in operation, our transportation question would be still unsolved. The cheap transportation of the Great Lakes would not be brought to the coast, and the ship canal would still offer a sufficient reduction in the cost of transportation to warrant its building and operation as a private enterprise. Yours truly, Chauncey N. Dutton.

1668 Bowling Green Building, New York city,
Nov. 22, 1897.

(Without attempting in any way to discuss the question our correspondent raises as to the economic value of a ship canal, we deem it proper to point out that, contrary to his expressed belief, the present Deep Waterway Commission is "fettered by its instructions." Under the terms of the appropriation under which it is working it can do nothing whatever save carry out the recommendations of the Cooley Commission and make detailed surveys and estimates for ship canals of deep draft on the routes which that Commission advised. Further, if we are correctly informed, the question whether such a ship canal would be a paying enterprise or not, and the broad question what is the cheapest and most advantageous plan by which freight can be carried from the Lakes to tidewater will not be taken up at all by the present Commission, unless Congress should issue further instructions to that effect, which we hope it may see fit to do.—Ed.)

Notes and Queries.

N. B. L. asks "whether or not it is now generally accepted as the best engineering practice on railways of heavy traffic to place the rail joints opposite each other."

We believe that it is now generally accepted as the best practice to place the joints in one line of rails opposite the centers of the other lines of rails, or, as it is generally called, to use broken joints. A few railways still lay tracks with square joints; but most of the important roads of which we have information use broken joints as their standard. As a matter of fact, we believe that the importance of the question is much less now than it was twenty years ago. Heavier rails, better ballast, improved joint construction and greater care in maintenance, have greatly reduced the deflection of track at the joints; and we believe that track can be made to ride as smoothly on one system as on the other. The broken joint system is, however, the more convenient, as in laying track round a curve the joints can run considerably ahead or back of the center of the opposite rail before it is necessary to cut a rail.

RAILWAY DRAWBRIDGES OVER THE CHICAGO DRAINAGE CANAL.

(With two-page plate.)

The Chicago main drainage channel will be crossed by five railway bridges, all of which will be of the center pier type. Four of these, which we describe in the present article, will be double-track structures as follows: One for the Chicago, Madison & Northern Ry., two for the Atchison, Topeka & Santa Fe Ry., and one for the Chicago Terminal Transfer Ry. The fifth will be an eight-track bridge for the use of the Pittsburg, Cincinnati, Chicago & St. Louis Ry., Chicago & Northern Pacific Ry., and Illinois Stock Yards & Transit Co., and will be on Section O of the canal, near Campbell Ave. As this bridge will call for special design we shall make it the subject of a separate article in a later issue.

The plans have been prepared under the direction of Mr. Isham Randolph, Chief Engineer, and Mr. W. M. Hughes, Bridge Engineer, of the Sanitary District of Chicago, subject to the approval of the chief engineers of the respective roads; Mr. David Sloan, of the Chicago, Madison & Northern R. R.; Mr. James Dun, of the Atchison, Topeka, Santa Fe R. R.; and Mr. F. E. Paradis, of the Chicago Terminal Transfer Ry.

Bridge for the Chicago, Madison & Northern Ry. (Fig. 1).—This is the largest of the four bridges, its length being 474 ft. 3½ ins. (c. to c. of end connections) between abutments (under the copings). A pivot pier 32 ft. 6 ins. diameter (under the coping) carries a 28-ft. turntable. The piers and turntables are alike for all the bridges. The trusses have nine panels of 25 ft. 4 ins. on each side of a center panel of 18 ft. 3½ ins., the depth being 30 ft. at the ends and 70 ft. over the turntable. The floor system is entirely above the bottom chords, and the rail level is 48.64 ft. above the bottom of the channel. The bottom width of the channel here, as at all the bridges, is 183.26 ft. and the width at top is 325.22 ft., which is about the same for the other bridges, while on the datum line the width is 281.82 ft. The angle between the center lines of channel and bridge is 30° 4′ 30″ and the backs of the bridge seats have a radius of 239 ft. 6¾ ins. The trusses are 30 ft. 3 ins. apart, c. to c., and the tracks are 14 ft. c. to c. This bridge is on Section N of the canal.

Bridge for the Atchison, Topeka & Santa Fe. Ry., at Lemont, Ill.—This bridge will be a double track structure, 368 ft. 3½ ins. in length, with a span of 364 ft. 3½ ins. between abutments, and a pivot pier 33 ft. 8 ins. diameter over the coping. It resembles very closely the C., T. T. Ry. bridge, shown in Fig. 2, but the compression members from the bottom of the central panel go to the top of the first instead of the second post, so that all the posts are entirely in tension, while in Fig. 2 the upper half of the first post is in compression and the lower half in tension. The diagonal struts, therefore, extend to the bottom of the first post, instead of the second post, as in Fig. 2. The angle between the center lines of the bridge and the channel is 54° 55′ 30″. The bridge trusses are

30 ft. apart, c. to c., with a depth of 30 ft. at the ends and 56 ft. over the pier. The counter panel is 18 ft. 3½ ins. wide, and on each side are 7 panels of 25 ft. The rail level is 48.78 ft. above the bottom of the channel. The radius of the back of the bridge seat is 186 ft. 3¼ ins. This bridge is also on Section N of the canal.

Bridge for the Atchison, Topeka & Santa Fe. Ry., at 26th St.—This bridge will also be almost identical with the one shown in Fig. 2. It will be 322 ft. 9½ ins. long, with 14 panels of 21 ft. 9 ins. and a center panel of 18 ft. 3½ ins. The

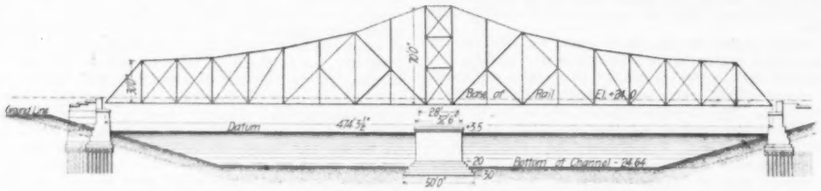


FIG. 1.—BRIDGE FOR THE CHICAGO, MADISON AND NORTHERN RY.

width between abutments (under the coping) will be 318 ft. 8 ins., with a pivot pier 33 ft. 8 ins. diameter (over the coping), carrying a 28 ft. turntable. The bridge is on a skew of 68° 22', and the backs of the bridge seats have a radius of 163 ft. 10 ins. The trusses are 30 ft. deep at the ends and 50 ft. at the center panel, and are 30 ft. apart, c. to c. The tracks are 14 ft. c. to c. This bridge will be on Section G of the canal.

Bridge for the Chicago Terminal Transfer Ry. (Fig. 2).—This bridge is a little shorter than the one above described, 312 ft. 3½ ins. c. to c. of end connections, the 14 main panels being 21 ft. long, and the width between abutments 308 ft. 3½ ins., with a radius of 158 ft. 3½ ins. for the back of the bridge seat. The angle between center lines of bridge and channel is 86° 24' 40". The clear headway over the rail is 22 ft. 5 ins., the depth and spacing of the trusses being the same as in the 26th St. bridge. This bridge is on contract Section E of the canal.

Substructures.

The substructures of all these bridges are practically identical, each consisting of a pivot pier of concrete and stone, on concrete foundations on the rock, and two abutments of stone masonry, with concrete foundations supported by piling.

Fig 3 shows the details of the pivot pier of the C., M. & N. Ry. bridge, Fig. 1. It is octagonal in form, 32 ft. 6 ins. in diameter under the coping, with two coping courses 18 ins. thick. The

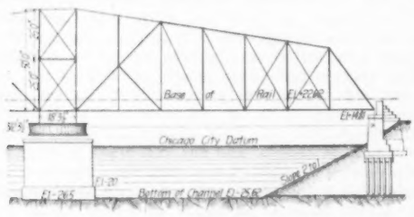


Fig. 2.—Bridge for the Chicago Terminal Ry.

height from the top of the foundation to the under side of the coping is about 20 ft. The foundations consist of 24-in. courses of Portland cement, each course stepped off 24 ins., and the two bottom courses forming continuous beds of concrete, as shown by the cross section. The heart or core of the pier is of natural cement concrete, and this is faced with massive rock-faced granite masonry, in courses of 24 to 18 ins. in thickness. The top of the concrete heart is covered with Portland cement concrete 18 ins. thick at the sides and 20 ins. at the center, where is a hole 5 ft. 1 in. in diameter, for the center casting of the turntable. On the top coping course is a groove 30 ins. wide for the turntable rack. The cramps are of iron with a section ¾ × 2½ ins. Their ends are turned down to a depth of 4 ins.

The other piers are of identical construction, with the exception of that for the C. & C. T. Ry. bridge, which has a concrete foundation 6 ft. 6 ins. thick and 36 ft. 6 ins. diameter, as shown by Fig 2. The masonry of the abutments for these bridges rests on a base of Portland cement concrete, with a timber platform supported on piles. The piles are to be of white or burr oak, 14 ins. diameter at the butt and 9 ins. at the smaller end, and are to be driven by steam hammers. The platform will be of white oak caps, 12 x 12 ins., secured to the piles by ⅞-in. drift bolts.

All stone masonry is to be of an approved quality of granite, Bedford stone being required for the copings of the piers and the bridge-seat courses of the abutments. It is specified that the stone must be quarried in time to season against frost before being used, and that explosives must not be used to excess, the stone being taken out whenever practicable by the use of plug and feather.

The following is an abstract of the specifications for stone masonry and concrete:

Specifications for Masonry Substructures.

Masonry.—All masonry shall consist of pitched draft, rock-faced work, built in regular courses, no course to be less than 12 ins. or more than 30 ins. in height, and in no case shall a course overlie one of less thickness. The rock shall not project less than 1 in. or more than 3 ins. beyond the pitch line joints.

Abutments and piers shall have chiseled draft 2 ins. in width on corners only. The stone shall be rectangular in form. No stretcher shall be less than 3 ft. or more than 6 ft. long, and the upper or lower bed shall be of a width not less than 1½ times the vertical height. Headers must not be less in length than 4 ft. or three times the thickness of the course when the width of the wall will admit of it; and always at least 1½ times the vertical height.

All stones must be laid on their natural beds, the largest bed down; the beds well dressed, parallel and true, and as large as the stone will admit of. The beds and sides of the stones to be cut before being laid, so as to form joints not exceeding ½-in. in thickness. The stone must be moistened before being laid and before any succeeding course is placed upon it.

Joints shall be horizontal and vertical, and the vertical joints shall break not less than 12 ins. Vertical joints shall be dressed close for at least 12 ins. back from the face.

All masonry shall be pointed with finely tempered cement mortar so as to fill the joints solid. The surface of the wall to be scraped clean and the joints freed of all mortar to a depth of 1½ ins. and refilled solid by using proper ramming tools. Joints must be well wet before pointing.

Cramps shall be fitted into the course after it is laid, and shall be countersunk; and all the holes shall be filled with grout made of Portland cement after the cramps are inserted.

Masonry shall not be laid in freezing weather without written permission from the Chief Engineer, and any masonry so laid in freezing weather shall have the joints raked out and pointed in the spring at the expense of the contractor. Should masonry be laid in freezing weather the stone shall be sufficiently warmed to remove all ice from its surface, and the mortar mixed with brine, made by dissolving 1 lb. of salt to 16 gallons of water when the temperature is 32° F., adding 1 oz. of salt for each degree below the temperature.

Concrete.—Portland cement concrete shall be made in the proportion of 1 part cement, 3 parts sand and 6 parts broken stone. It shall be mixed by machinery, if so directed, or if mixed by hand it shall be done upon a suitable platform. Care must be taken to first thoroughly mix the dry cement and sand; after which stone shall be added, together with a proper amount of water, all to be thoroughly mixed; water to be applied by a sprinkling pot; on being placed, the concrete shall have a wetness such as to permit quaking or liver-like mobility. The stone for concrete shall be broken into angular pieces of a size small enough to pass through a ring 2 ins. diameter, and be entirely free from dust, sand, dirt and any foreign substance. The stone must be thoroughly drenched with clear water before mixing with the mortar. The concrete is to be deposited in layers not exceeding 6 ins. in thickness, as directed, and to be thoroughly tamped or rammed.

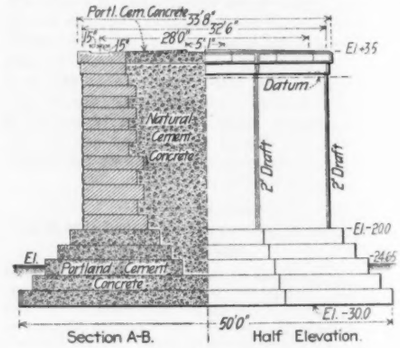
Natural cement concrete shall be made in the same manner as specified above for Portland cement concrete, except that the proportion shall be 1 part cement, 2½ parts sand and 5 parts broken stone.

Cement and Mortar.—The best Portland and natural cements shall be used on this work. The weight of Portland cement shall be not less than 100 lbs. per cu. ft., and of natural cement not less than 67 lbs. The development of tensile strength for Portland cement shall be not less than 400 lbs. per sq. in., and for natural cement not less than 100 lbs. per sq. in., after being exposed one day in air and six days in water. The sand shall be coarse, clean and sharp, free from all clay, loam or gravel, and shall be well screened. When Portland cement mortar is used for beds and joints it shall be mixed in proportions of 1 part cement to 3 parts sand. When used for grout, 1 part cement and 2 parts sand. When used for pointing, 1 part cement and 1 part sand.

Superstructure; C., M. & N. Bridge.

As already noted, all these bridges will have pin-connected through trusses, and we have selected the bridge of the Chicago, Madison & Northern Ry. for description in detail, as an example of the type of construction, the others differing mainly in dimensions and minor details. The strain sheet of this bridge, together with the composition of the members, are shown in Fig. 4.

Trusses.—The trusses are 474 ft. 3⅜ ins. long, 30 ft. high at the end posts and 70 ft. high at the middle posts, and are spaced 30 ft. 3 ins. apart c. to c. The width of the center panel is 18 ft. 3⅜ ins., and on each side of this are nine panels of 25 ft. 4 ins. The top lateral system consists of transverse members between the posts and rod diagonals in each panel, while the bottom lateral system consists of angle iron diagonals in every panel. The trusses are also connected by ample portal bracing and sway bracing above, and by the heavy plate girder floor beams below. The character of the truss design is shown more in detail in Fig. 5, and a peculiar feature to be noted here is that there are no end pins, heavy riveted connections being used for the junction of the top and bottom chords. Both chords are built up of riveted members, with top and bottom bracing, and riveted gusset plates connect the ends of the posts with the chords. Eyebars are used for the inner posts, the diagonals, and the top chord connections with the center panel. It will be noted that all connections are very substantially made. Fig. 6 shows the details of the connection at panel point M-6, where the diagonal strut L-7, M-6 meets the vertical L-6, U-6, and the diagonal L-5, U-7.



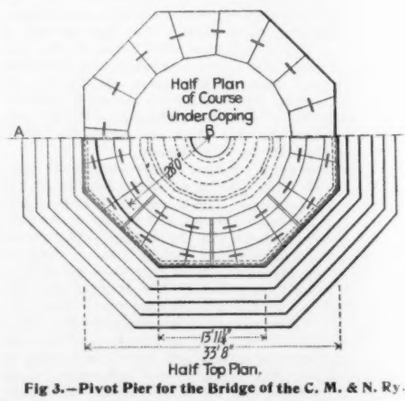


Fig 3.—Pivot Pier for the Bridge of the C. M. & N. Ry.

The pins vary in diameter from 4 ins. at the end vertical posts to 11 ins. in the top chords. For pins of 5 ins. diameter and over, either Lomas nuts or recessed washers with tap or through bolts may be used, at the option of the contractor, but pins less than 5 ins. diameter must have Lomas nuts. If recessed washers are used, the diameter must be not less than 1½ ins. greater than that of the pin, and the bolts must be 1 in. diameter for pins of 6 ins. diameter or less, and 1½ ins. for pins of more than 6 ins. diameter.

All rivets are to be ⅞-in. diameter, unless otherwise noted, and all hand-driven rivets will be of iron. Where rivets are passed through the flanges of 10-in. and 12-in. channels, they are to be ¾-in. diameter. The rivet spacing in chords and posts will be 3 ins. for a distance of about 2½ times the depth of the member, on each side of the panel points; beyond that, the spacing will be 4 ins. in flanges of chords and end posts, and not over 6 ins. in intermediate posts, unless otherwise noted.

Wedge-shaped fillers of cast steel are to be used at the ends of top struts, between the top flange angles of the struts and the gusset plates of the chord, when necessary.

Floor System.—The floor is of very heavy construction, and consists of floor beams and track stringers. The middle floor beams (or loading beams), which rest upon the turntable drum, are riveted trusses 7 ft. 6 ins. deep, as shown in Figs. 7 and 8. The top chord is composed of four 15-in. channels, 33 lbs. per ft., and eight plates 9-16×15 ins., while the bottom chord consists of four 15-in. channels, 55 lbs. per ft., and two plates 13-16×15 ins. The rivets are ⅞-in. diameter, except that ¾-in. rivets are used in the flanges of 10-in. and 12-in. channels. The other floor beams are plate girders 5 ft. deep, all practically similar to the end floor beam shown, together with the details of the end latch, in Fig. 9. Floor beams connected to the built-up posts of the truss have angles 7-16×6×6 ins., 7 ft. 6 ins. long, riveted to the inner face of the post and to the web of the beam, as shown in the cross section on Fig. 5. Where the posts are eyebars, the ends of the beams are riveted to hanger plates on the pins, these hangers being riveted also to the chords, the pins being above the level of the top of the floor beams. Where the posts consist of four eyebars (as in panel point L-7) there are four hanger plates ⅝×38 ins., 8 ft. 1 in. long and somewhat narrowed at the top.

The track stringers are plate girders 25 ft. 4 ins. long, 4 ft. 3 ins. deep, with web plates ⅜×51 ins., two top and two bottom angles 9-16×6×4 ins., and divided into panels by vertical angle iron stiffeners, each consisting of an angle iron ⅜×5×3 ins., crimped to fit over the legs of the flange angles. They are spaced 6 ft. 6 ins. apart for each track, the inner lines of stringers being 7 ft. 6 ins. apart. The track itself is shown in Fig. 10. The rails rest on ties 8×8 ins., 10 ft. long, dressed on all sides, and notched ½-in. over the track stringers, to which they are secured by hook washers on the ¾-in. bolts which fasten the guard timbers, these bolts being used in alternate ties. There are inside iron guard rails, 8 ins. clear from the track rails, and outside guard timbers 6×8 ins., not less than 24 ft. long, laid flat, notched ½-in. over the ties, and bolted as described. These timbers are 143/8 ins. from the gage side of the track rail. All timber is to be "first quality long-leaf, yellow, heart pine, free from sap, and cut from live trees grown south of the south line of Tennessee."

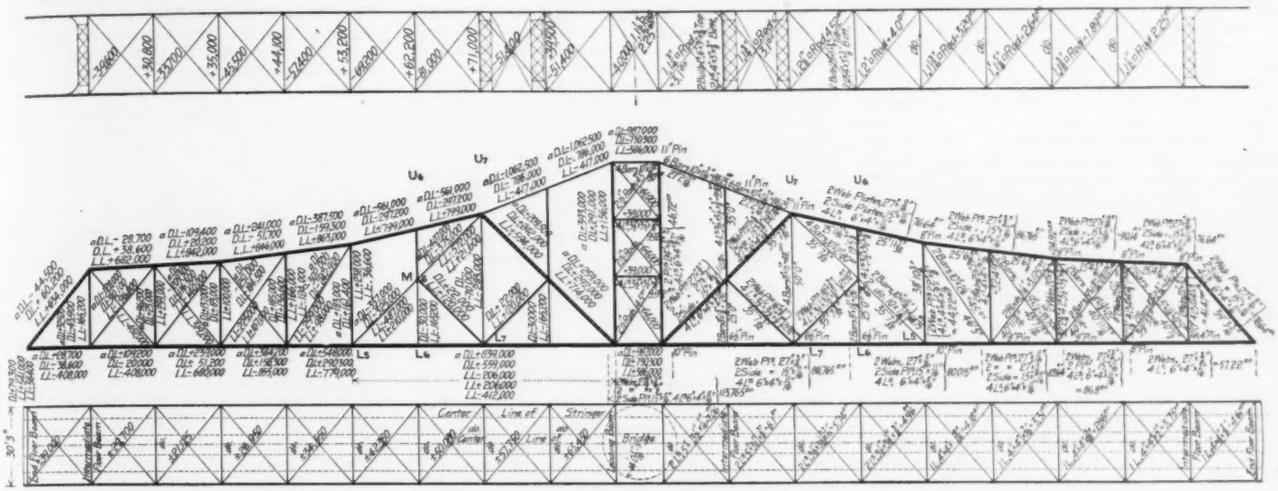


FIG. 4.—STRAIN SHEET AND MAKE-UP OF TRUSSES OF BRIDGE OVER THE CHICAGO DRAINAGE CANAL; C. M. & N. RY.

End Lifts and Latches.—At each end of the bridge will be an end lift arrangement, consisting of two compressed air cylinders, set horizontally, one under the end of each truss, as in Fig. 11. The piston rod of each will carry at its end a cast-steel wedge, with the upper face horizontal (bearing on a seat under the floor beam) and the lower face inclined 1 on 6, bearing on the cast-iron shoe bolted to the bridge seat of the abutment. The end latch, shown in Fig. 9, consists of a roller carried at the lower end of a vertical slide. As the bridge closes the roller runs up the inclined face of the cast-iron rest for the latch (on the masonry) and drops into place in the top groove of the seat. To release the latch, the slide is pulled up by the rod shown, which raises the roller clear of the groove. All sliding and bearing surfaces are to be tool finished.

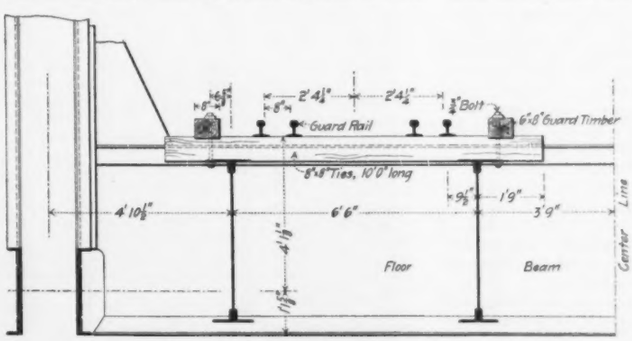


FIG. 10.—CROSS SECTION OF TRACK.

Turntable.—The weight of the bridge when swinging is transmitted by the two middle floor beams (or loading beams) to a drum 28 ft. diameter and 7 ft. 7ins. deep, consisting of a plate-girder ring with cast-steel seats for the two beams. This ring has a web plate 13-16×79 ins., two top and two bottom angles ¾×6×6 ins., and vertical stiffeners of angle iron ⅝×4×4 ins. It will be built to a true circle, care being taken to have the lower edge of the web plate and the flanges of the bottom angles bear uniformly upon the roller track. To the inner circumference of the ring are riveted (at the shop) four plate-girder "chord beams," the ends of which are curved to fit against the inside of the ring, as shown in Fig. 12. In the center of the drum is a cast-steel spider, the hub of which has a phosphor-bronze bushing for the 8-in. center pin, and the 24 arms of which carry 24 riveted radial trusses, the outer ends of which are riveted to the web of the drum, holding it in form and position.

To the masonry of the pier are secured the cast-iron center casting and the base casting for the roller track, the anchor bolts being 1½×24 ins. for the former and 1½×12 ins. for the latter. The top of the center casting forms the 8-in. center pin engaging with the hub of the drum, and below this is a portion faced to a diameter of 18 ins. to receive two ½-in. plates, 4 ft. 9 ins. diameter, with an 18-in. hole in each. Between these plates rest the ends of the 56 radial rods which carry the rollers. Each rod is 1½ ins. diameter, with the inner end flattened to lie between the plates and formed with an eye for a 1½-in. pin, and the outer end passing through the roller and having a faced and bored phosphor-bronze washer against which the roller bears, the washer being held by lock nuts. The rollers are of cast-steel, 18 ins. diameter at the center and 12 ins. wide on the face, the face being turned to a conical incline of 9 to 168. Two roller rings of 6-in. channels, 13 lbs. per ft., hold the rollers in position. A cast-steel circular track, tool finished on both sides, is secured to the bottom of the drum by countersunk bolts, and this rests upon the rollers, which in turn rest upon a similar track bolted to the cast-iron base ring anchored to the masonry of the pivot pier. This base is built up in sections, bolted together, and is tool finished on top to receive the track and on the face to receive the rack castings, which are bolted to it. The rack is of cast steel, in 16 sections, with the ends milled to exact length, and with the back tool-finished to bear against the face of the base casting. The rack has a diameter of 31 ft. 3 21-32 ins. on the pitch line, and has 320 teeth, 3 11-16 ins. pitch. The rack pinion will have 16 teeth, and will be carried on the lower end of a vertical shaft 5 ins. diameter, as shown.

Before the base is set and levelled up, the interior of the castings will be filled with Portland cement concrete composed of 1 part cement to 1 part sand and 1 part limestone screenings. In the groove made in the masonry for the turntable tracks will be a cement filling upon which the base casting will rest. This will be composed of 80% brimstone, 5% asphaltum and 15% bituminous limestone (by weight). These quan-

tities will be placed together in a heating vessel and kept at a temperature of 300° F. for about 30 minutes. The temperature will then be reduced to about 250°, in order to let the heavy foam settle, after which the material will be run into molds for cooling. This material is to be remelted without foaming, and will be run under the tracks in such a way as to insure the filling of all voids. The brimstone is to be that known as commercial unmixed (seconds); the asphalt is to be that mixed and refined (solid) by the Standard Asphalt Co., of California, containing 93% of asphaltic bitumen; the bituminous limestone (Wasatch) is to be that mined in Utah and pulverized to "cyclone" size by the Assyrian Asphalt Co.

All bolts for masonry which are embedded in this cement filling will be coated with a composition of 45% melted asphalt, to which is added 55% of pulverized green limestone which has been heated to 400° F. These materials are to be thoroughly mixed at a temperature of 350°, and the composition then run into molds to cool off. For use, this will be remelted, and used to coat the bolts, the bottom of the base casting and the cement filling of the same. After the track is set, all edges of the cement which come in contact with the cement filling under the turntable tracks will be given a coat of the same composition.

Conditions of Loading.—The following is the description of the loading, as taken from the drawings:

Dead Load, 5,320 lbs. per lin. ft. of bridge, ends touching and ends raised 2 ins. Total deflection assumed, 6 ins.
Live Load (Continuous Girder):
4,940 lbs. per ft. of truss, moving from L-0 to L-0 on near track.
4,200 lbs. per ft. of truss, moving from L-0 to L-0 on far track.
(Simple Girder):
4,940 lbs. per ft. of truss, moving from L-0 to L-9 on near track.
4,200 lbs. per ft. of truss, moving from L-0 to L-9 on far track.

Continuous girder of four supports, with equal moments at center supports:

	Live Load. ft.-lbs.	Dead Load. ft.-lbs.
Int. floor beams, max. moment.....	1,343,000	181,000
" " " max. end shear...	165,200	22,800
End floor beams, max. moment....	1,044,000	118,000
" " " max. end shear...	128,200	13,800
Stringers, max. moment.....	335,500	31,700
" max. end shear.....	59,800	5,000

The stresses in the longitudinal bracing in the center panel were calculated to transfer a shear across this panel due to an unbalanced load of 12,000 lbs. suspended from one end of the bridge only.

Tests.—When the bridge is completed it may be subject to the following test: Two consolidation locomotives, coupled together, will be run over it at a speed of 15 miles per hour, and when the leading engine is over the center of the bridge both engines will be reversed. This test must show no permanent change in any part of the structure. The bridge may then be fully loaded with engines of the same class, and after it has sustained this load for five minutes it must not show a greater deflection than 1-1,200 of its length, while upon the removal of the load it must return to its original camber. The amount of this camber is specified to be not less than the deflection under extreme loads.

Specifications.—The following is an abstract of the specifications for the superstructure work:

Specification for Superstructure.

Wrought Iron.—All iron for rivets shall have an ultimate tensile strength of not less than 48,000 lbs. per sq. in., an elastic limit of at least 26,000 lbs. per sq. in., and an elongation of at least 20% in 8 ins., and be so ductile that when bent cold through 180° and hammered down flat on itself, it shall show no sign of fracture on convex side of curve. All hand driven rivets, whether shop or field, will be of iron.

Steel.—All steel shall be uniform in quality and made by the open hearth process. Tests shall be made upon pieces cut from the finished material and of not less than ½ sq. in. sectional area. Two pieces, one for tensile test and one for bending test, shall be furnished for each blow or cast, and so selected that each heat or furnace-full of billets, blooms or slabs shall be represented by at least one test to prove the condition of the metal after reheating, rolling, etc.

Medium steel shall have an ultimate tensile strength of from 60,000 to 68,000 lbs. per sq. in., an elastic limit of not less than 36,000 lbs. per sq. in., shall elongate not less than 25% in 8 ins., and show a reduction of area at a point of fracture of not less than 40%. The test piece must also bend cold 180° around a curve whose diameter is equal to the thickness of the piece without crack or flaw on convex side of bend. A hole punched for a ¾-in. rivet, ½-in. from the edge of the plate, shall be capable of being enlarged by drifting to 1½ ins. diameter without sign of fracture.

Full sized steel eye-bars, when tested to destruction, must show an ultimate strength of at least 56,000 lbs. per sq. in., an elastic limit of not less than 30,000 lbs. per sq. in., and shall elongate 25% in a gaged length of 12 ins. at the point of fracture and 15% in 10 ft. of bar, with a reduction of area at fracture of at least 15%. For steel pins the elongation may be 5% less and the reduction at point of fracture 10% less than specified.

Soft steel shall have an ultimate tensile strength of from 52,000 to 60,000 lbs. per sq. in., an elastic limit of not less than 30,000 lbs. per sq. in., and shall elongate not less than 25% in 8 ins. and show a reduction in area at point of fracture of not less than 50%, except in web plates over 36 ins. wide, when the elongation will be reduced to 20% and the reduction of area to 40%. It must also bend cold through 180° and close down upon itself without showing sign of fracture on convex side of bend. A hole punched for a ¾-in. rivet, and 1½ ins. from the edge of plate, shall be capable of being enlarged by drifting to 1½ ins. diameter without sign of fracture.

Rivet steel shall have an ultimate strength of 50,000 to 58,000 lbs. and an elastic limit not less than 55% of the ultimate; an elongation of not less than 27% and must bend 180° flat on itself without sign of fracture on the convex side of the bend. All hand driven rivets, whether shop or field, shall be of the best quality of rivet iron, as specified.

Specimens taken from all grades of steel, after being heated to a light cherry red (as seen in the dark), and quenched in water of 82° F., must conform to the bending requirement above.

The chemical analysis for carbon and phosphorus of each blow or cast must be furnished to the engineer, or his inspectors, before any of the material rolled from said blow or cast is shipped from the mill. Phosphorus must not exceed 0.08% for acid steel, or 0.06% for basic steel.

Steel castings shall have an ultimate strength of not less than 62,500 lbs. per sq. in., an elastic limit of not less than 30,000 lbs. per sq. in., shall elongate not less than 15% in 8 ins., and show a reduction at point of fracture of not less than 20%. The amount of phosphorus contained shall not exceed 0.07%. All steel castings shall be sound and free from blow holes and roughness, sponginess, pitting, shrinkage-cracks and other cracks, cavities, etc., and shall be thoroughly annealed according to the best practice.

Cast-Iron.—Castings must be the best quality of soft gray iron, free from flaws, ragged edges, or any other defects. Bars of 1 sq. in., placed 4 ft. 6 ins. between supports, must be strong enough to bear a weight of 500 lbs. placed half way between supports.

Phosphor-bronze castings shall contain 88% of copper and 12% of phosphorized tin. The phosphorized tin shall contain 5% phosphorus. Test pieces must show a good uniform metal, and at least 40,000 lbs. ultimate tensile strength.

Painting.—All iron work for the Chicago Terminal Transfer Ry. Co.'s bridge, before leaving the shop, shall be thoroughly cleaned from all loose scale and rust, and be given one good coat of No. 31 paint of the National Paint Works, Williamsport, Pa., or paint of equal excellence, well worked into all joints and open spaces. In the riveted work, the surfaces coming in contact shall each be painted before being riveted together. Bottoms of bed plates, bearing plates and any parts which are not accessible for painting after erection, shall have two coats of paint of the same brand. After the structure is erected, the iron work shall be thoroughly and evenly painted with two additional coats of paint, No. 31 special of the National Paint Works, Williamsport, Pa., or paint of equal excellence. All recesses which will retain water, or through which water can enter, must be filled with thick paint or some waterproof cement before receiving the final painting.

All iron work for the Chicago, Madison & Northern Ry. bridge, before leaving the shop, shall be thoroughly cleaned from all loose scale, rust, grease, dirt or any other foreign matter, and shall be given one good coat of the "Durable Metal Coating" manufactured by Edward Smith & Co., of New York City, which shall be well worked into all joints and open spaces, all parts which may ever be exposed to the weather or to the action of moisture being thoroughly covered. In riveted work the surfaces coming in contact shall each be painted before being riveted together, with one good coat of iron oxide paint, composed of the purple oxide of iron well mixed in pure linseed oil. The bottoms of bed plates, bearing plates and any other parts which are not exposed for painting after erection, shall have two coats of the "Durable Metal Coating." After the structure is erected the iron work shall be thoroughly and evenly painted with two additional coats of a special black paint, which will be furnished by the Illinois Central R. R. Co., and is used as a standard in all their bridge work. This will be furnished to the contractor at a cost to him of 75 cts. per gallon. All recesses which will retain water or through which water can enter, must be filled with thick paint or some waterproof cement before receiving a final painting.

THE FORMAL OPENING OF THE NEW HOUSE OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

On the afternoon of Wednesday, Nov. 24, a large audience assembled in the auditorium at the new house of the American Society of Civil Engineers for the exercises in connection with the formal opening of the building. Prayer was offered by Rt. Rev. Henry C. Potter, Bishop of the Diocese, and President Benj. C. Harrod then presented an address, in which he set forth the solidarity of the engineering profession, and urged the peculiar claims of a national society upon it. We quote as follows:

It is worthy of consideration whether we are not losing sight of the essential unity of the profession, and of the truth that while mining, sanitary, electrical, or other lines of engineering may be differentiated in practice by the exigencies of the times, yet there is not only a remainder after these are taken away, but an organized body of correlated truths forming the roots and trunks of a great tree of knowledge of which these are but the branches.

With this view the birth, the growth of every special or local society, and the expansion of the field of its labors, is but another reason for co-ordination and the application of their accumulated influence and resources to a common purpose, to the promotion of learning and the prosperity of our profession through the agency of a single organization in which all may find representation and alliance.

* * * * * *

This Society stands for the increase of both general and special scientific culture in Civil Engineering; for the extension of professional and personal fellowship, based on this general culture, among engineers engaged in any of its various branches, and in all parts of the country; and for such just increase in the standards, the dignity, the rights and the emoluments of the profession as may be expected to follow earnest and intelligent organization and co-operation. This house is dedicated to these uses.

Gen. Wm. P. Craighill, Past-President of the Society and late Chief of Engineers, then addressed the members, taking as his special topic the distinguished services which have been rendered by the Corps of Engineers. He said that it had been sometimes asserted that service in the Corps of Engineers unfitted an army officer for the command of troops in actual warfare. To disprove this he cited the distinguished services of members of the corps in the Civil War, stating that such distinguished commanders as Rosecrans, Lee, Meade, Longstreet, Beauregard, McClellan and others were members of the Corps of Engineers

Following General Craighill's address, President Harrod read a cabled message from the Institution of Civil Engineers congratulating the American Society upon its entrance to its new building. He then introduced President Schurman, of Cornell University, who in a scholarly address pointed out that while America had nothing in art or philosophy to rank with treasures of the Old World, it could well be proud of its great engineering achievements. The progress of the world to-day in civilization is due more than anything else to the labors of the engineer. This is notably true of the continents of Asia and Africa.

As a profession, engineering is entitled to rank with the older professions by the fact that its members require a longer course of study than is necessary for entrance to the professions of law or medicine. The best schools of engineering today require a knowledge of mathematics for entrance quite equal to that formerly required in the old-fashioned colleges of the graduate from the Bachelor of Arts course. In conclusion he said that Prospero in Shakespeare's "Tempest" seemed to him to have set forth the ideal embodiment of the engineer, as also the embodiment of the genius of true Christianity.

The last speaker of the day was Hon. Joseph H. Choate. He compared engineering with the other learned professions, and declared that engineering was superior to law or medicine, in that the engineer works from known and certain premises to inevitable conclusions, while the other professions are based on opinion and judgment.

When the doctor loses his patient it is never his fault. He goes on to acquire new patients and new fame. When the lawyer loses his case it is never his fault. He can always trace it to the infirmities of the law, or the weakness of the judge, or the dullness of the jury, or the evil conduct of his client. But it is not so with the engineer. If his bridge falls, he falls with it. Again, our works perish. The breath of the lawyer is the measure of his fame. The practice of the medical profession changes from age to age; but the works of the engineer live after him as an enduring monument to carry down to a distant posterity his merits and his defects.

The speaker then went on to show that only the

progress in engineering and the improvement in means of transport and communication had made possible the existence of the United States as it exists to-day. As Mr. Seward said at the outbreak of the Rebellion, "No parchments, no laws will hold this nation together; but bridges and railways and steam and the telegraph—they will and must do it." In conclusion he quoted Emerson's famous phrase, "Hitch your wagon to a star," and declared that the sentiments embodied in the speech in which that phrase occurred seemed to him especially intended for engineers.

The exercises of the afternoon were concluded with the adoption of suitable resolutions offered by Past-President Geo. S. Morison thanking the representatives of the law, the clergy and the University who had addressed the Society, and acknowledging the congratulations sent by the Institution of Civil Engineers.

In the evening a largely attended reception was held in the new house, and its adaptability to social purposes was well tested.

A COMPETITIVE TEST OF A HOLLOW TILE AND A CONCRETE FIREPROOF FLOOR.

In our last issue we described briefly the conditions and results of a competitive test made to determine the comparative resistance of a hollow tile floor arch and a Roebling concrete floor arch to repeated attacks of fire and water. This test grew out of a challenge made by Henry Maurer & Sons, of New York city, who are prominent manufacturers of hollow tile fireproofing, to manufacturers of other kinds of fireproofing to take part in a continuous 24-hour competitive test of fireproof floor arches to be conducted under the auspices of the New York Department of Buildings. The firm of John A. Roebling's Sons Co. accepted this challenge, agreeing to submit a concrete floor arch of the standard Roebling type for a test in competition with the hollow tile arch, but with the proviso that the hollow tile should be purchased in the open market, and should not be especially burned for the test; the test was also to be a fire and water test of the same nature as those previously made by the New York Department of Buildings. The fire was to burn for five hours, during the last three of which the temperature should not be less that 2,000° F. At the end of the five hours, when the temperature was to be at least 2,100° F., a stream from a fire hose at 60 lbs. pressure was to be applied to the under side of the arches, and at the same time the tops of the arches were to be flooded with water. The application of the water was to continue for 15 minutes. In case both arches withstood the first test, the fire was to be renewed as soon as practicable and the test repeated until one of the arches was destroyed.

A brick and skeleton steel structure, 12 × 14 ft., inside dimensions, was erected for the purpose of the test. The entire interior area corresponding to the floor of a building was a main grate, consisting of flat steel bars set on edge and resting on parallel brick walls. At a distance of 1½ ft. under the main grate was a secondary grate, on which fuel might be fed from the outside through openings in the wall. Suitable openings were also provided, that fuel might be fed on the main grate. Ten feet above the main grate, corresponding to the ceiling and a story of a building were the two forms of fireproof flooring to be tested, constructed between four iron beams, 10 ins. deep and weighing 25½ lbs. per lin. ft. These beams were bolted to plates which rested on the end walls. The beams were spaced so as to form two spans of 5 ft. each, with a distance of 16 ins. between the two middle beams. Filling the space between the two beams on the west side was a concrete arch, constructed according to the Roebling system. The space between the beams on the east side was filled by an end construction, "Excelsior" pattern, hollow tile flat arch. Above these arches was a concrete filling, representing the usual practice, to bring the fireproofing to the level of the wood floors. At each of the four corners of the structure, a short distance below the fireproof floors, were openings through the brick walls which communicated with four pipestacks, 15 ins. in diameter and 14 ft. high. Two thin iron plates, with graphite grease applied to the surfaces, separated the two arches from each other along the center line of the structure, and similar plates along the side walls separated each of the arches from the walls. These plates were to permit each arch to deflect independently of the other. Eighteen definite points were provided with a leveling rod, and readings to be taken by two independent levels were to provide the necessary data to note accurately the deflection of each arch.

VIEW SHOWING COMPARATIVE DAMAGE DONE TO A HARD TILE ARCH AND TO A ROEBLING CONCRETE FLOOR ARCH BUILT SIDE BY SIDE AND SUBJECTED TO A FIRE TEST FOR 3 HRS. 16 MINS.

The following describes the character and construction of the two arches: Arches erected, Oct. 17, 1897; filling above arches put in, Nov. 11, 1897; ceiling plastered (Rock Wall Plaster), Nov 12, 1897; load applied (150 lbs. per sq. ft., uniformly distributed), Nov. 18, 1897; thickness of concrete at crown of Roebling arch, 3 ins.; depth of hollow hard tile arch, 8 ins.; depth of concrete filling over hollow tile arch, 4 ins.; depth of concrete filling over Roebling arch, 2 ins.; proportions of concrete in Roebling arch, 1 part Aalborg Portland cement, 2 parts Cow Bay sand, 5 parts steam ashes (unscreened); proportions of cement mortar in tile arch, 1 part Aalborg Portland cement, 2 parts Cow Bay sand; proportions of concrete filling over both arches, 1 part Brooklyn Bridge brand Rosendale cement, 2 parts Cow Bay sand, 8 parts steam ashes, unscreened.

The Roebling arch in the test was, it is stated, identical in every particular as to proportions, manipulation, etc., with the fireproof arches erected by the John A. Roebling's Sons Co., in the Bowling Green Building, 5-11 Broadway; the new Hotel Renaissance, 5th Ave. and 43d St.; and other buildings in New York city, and represented the standard construction of that company. The hollow tile arch was the Excelsior pattern, end construction, hard tile, type of flat arch erected with care so as to represent as nearly as possible first-class workmanship as found in fireproof buildings now in the course of construction in New York city. Both arches were erected under the direction of the employees of the Department of Buildings, Mr. Howard Constable, Consulting Engineer in charge of the fireproofing tests of the Department, superintending the work. The officers of the Department of Buildings state that every precaution was taken to secure good average construction in both arches, according to the standards of good practice in fireproof floor construction in New York city. To be certain on this point a number of the inspectors employed by the Department and a number of outside builders were requested to examine the work. These persons signed a statement to the effect that the construction of the tile arch was superior if anything to the standard practice in such construction in New York city.

The date of the test was made Nov. 19. On Nov. 18 the firm of Henry Maurer & Sons secured an injunction restraining Mr. Stevenson Constable, Superintendent of the Department of Buildings, and Mr. Howard Constable, Consulting Engineer, from taking part in the test. The petition for the injunction set forth that the tests were to be conducted in such a manner as to be unfair to the tile arch floor, and alleged that there was collusion between Mr. Stevenson Constable and Mr. Howard Constable and the firm of John A. Roebling's Sons Co. In a printed circular the firm of Henry Maurer & Sons made public their reasons for considering the test to be unfair. Briefly summarized, this circular stated that a hard tile floor, 8 ins. thick, was being tested when the approved practice of the firm was to use a porous terra cotta tile floor, 10 ins. thick; it was also asserted that imperfect and broken tile had been used in constructing the arch and that part of the tiles used were not of the firm's own manufacture. The manner of making the test was claimed to be unfair, since in actual fires the floors were never alternately subjected to fire and water, as would be done in the proposed test.

In obedience to the orders of the Court the Department of Buildings made no test of the floors. The firm of John A. Roebling's Sons, however, carried out the test on the lines which had previously been laid down by the Department of Buildings. The engineers employed by John A. Roebling's Sons to conduct the test for them were: Messrs. H. M. Hoge, M. Am. Soc. C. E.; Gus. C. Henning, M. Am. Soc. M. E., and Geo. L. Heins, of the firm of Heins & La Farge, Architects, of New York, N. Y. Mr. Wm. F. Rudolphy, City Surveyor, of New York, was employed to record the deflections of the two arches during the test.

The fire was started under the two floors at 11.50 o'clock a. m., on Oct. 19, 1897. A Uehling-Steinbart pyrometer, inserted through the end wall of the building on the line of intersection of the two arches, was used to record the temperatures. At 12.45 p. m., the pyrometer registered a temperature of 1,500° F., which increased to 2,000° F. at 1 o'clock p. m. From this time until 3.6 p. m. the temperature rose gradually, with slight fluctuations, to 2,300° F. At this time, or 3 hrs. 16 mins. after the fire was started, a portion of the middle of the tile arch, about 5 × 5 ft., fell through. The greatest deflections of the two arches previous to the destruction of the tile arch were: Roebling concrete arch, 1.4 ins.; hard tile arch, 3.65 ins.

The accompanying illustration, reproduced from a photograph taken the day following the test,

and without anything having been disturbed, shows quite clearly the appearance of the two arches after the test. An examination made by one of the editors of this journal immediately after the tile arch fell showed the following conditions: As far as could be seen the Roebling arch remained practically intact. The finish coating of white plaster on the under side of the arch had peeled off in spots, and hung loosely in other places, but the brown coat of plaster next to the concrete remained perfect. This feature is very clearly shown by the illustration. The tile arch had fallen through in the middle, as just stated, the only part remaining between the beams at the break being the skew backs, which still clung to the beams.

On Nov. 29 the Roebling arch was subjected to a number of tests to show its strength after undergoing the test by fire. A portion of the arch 45 ins. long, parallel to the supporting beams, was cut apart from the remainder, and pressure was applied to an area of 1 sq. ft. at its center. The pressure required to break the arch through was 11,500 lbs. A similar section 1 ft. long, parallel to the supporting beams, at the opposite end of the arch, was separated and tested in the same manner. The weight required to break this 1-ft. section was 2,950 lbs. A section of 18 ins. was then separated and subjected to a drop test from a stone weighing 281 lbs. and falling 5 ft. Three blows of this character were required to break the arch. Several other tests of a similar nature were made on other parts of the arch and showed equally good results.

THE TERMS OF THE PHILADELPHIA GAS LEASE.

The main features of the Philadelphia gas lease, the execution of which by Mayor Warwick is awaiting the decision of the court regarding its validity, are as follows: The lease is for 30 years, the city having the right to resume control at the end of ten years on paying the United Gas Improvement Co. a sum equal to all the expenditures for betterments to the plant, with interest at 6%. The company agrees to pay the city the appraised valuation of all gas in holders and material in hand for carrying on the business and extending the plant. It also agrees to expend at least $15,000,000 for the improvement and extension of the plant during the lease, $5,000,000 of this sum to be expended within the next three years. Certain real estate of considerable value, now occupied by a part of the city gas works, is to be released by the company in a short time. Gas for public buildings and the present number of public street lamps is to be furnished free by the company and also for 300 additional street lamps each year.

The price for gas sold to private consumers shall be $1 per 1,000 cu. ft., unless the city council lowers the price, but councils shall not reduce the price below certain figures within stated periods, as follows: 1898 to 1907, inclusive, 90 cts. per 1,000 cu. ft.; 1908 to 1912, 85 cts.; 1913 to 1917, 80 cts.; 1918 to 1927, 75 cts. In case councils do not by ordinance reduce the rates to these prices all revenues collected in excess of the figures named shall be paid into the city treasury. In other words, councils have the option of securing the advantage of lower prices for gas either for consumers or for the city as a whole. The city is to have access to the books of the company to determine what part of the revenue from consumers is due it.

The gas is to be of good quality and of at least 22 c. p. daily average. The company is to maintain testing stations and make tests daily at its own expense, in the presence of a representative of the city, allowing the latter the use of its stations and apparatus for the making of independent tests whenever desired.

For every failure of the company "to comply with the terms and conditions of this clause relative to tests, quality and candle-power of gas" the company shall pay to the city a penalty of $500 per day for each day during which said failure continues. In case the company can afterwards show that the failure was beyond its control the city must repay the fine.

The company must extend the street mains "as may be necessary to meet the demand for gas," provided that at least one consumer be assured for every 100 ft. of extension. All service pipes from the street main to a point inside the property line, all shut-offs at the curb and all meters shall be furnished and put in place by the company without charge to the consumer. Services to street lamps shall also be furnished and laid at the company's expense, and the lamps maintained, repaired and cleaned without expense to the city. The company shall also pay the city $10,000 a year towards the expense of the city gas inspectors. The contract also makes provision for the testing of meters in case of disputes over bills.

At the conclusion of the lease on Dec. 31, 1927, the company is to deliver the plant to the city in good condition, including all betterments and improvements, without cost to the city, the city to pay for all gas in the holders and to have the option of buying other material on hand at an appraised valuation.

Since the above was put in type the court has decided that the lease is valid, and it has been executed. The case may be carried to the Supreme Court, but the company expects to take immediate possession of the works.

THE POWER TRANSMISSION LINE FROM NIAGARA Falls to Buffalo is being increased in capacity, owing to the increasing demand for power from Buffalo. The three wires now strung on the poles will be increased to six. An order for cable and for transformers has been placed with the General Electric Company. The cable is insulated to stand the ultimate pressure of the line, which will be 22,000 volts, and is tested under a considerably higher pressure before leaving the works. Twenty-four thousand ft. of this cable will be used at first for that part of the transmission line within the city of Buffalo. The order for step-up transformers covers seven of similar size and design to the three already installed in the transformer house of the Niagara Falls Power Company. These ten transformers are the largest ever built. Each has a capacity of 1,250 HP., making a total step-up transformer capacity of 10,000 HP. They are of the air-blast type, and will stand in rows of four upon the air-tight chamber, whence the air is forced through the ventilating spaces in the transformers. The transformers take the two-phase current at 2,200 volts delivered by the 5,000-HP. generators in the power-house, and change it to a three-phase current at 11,000 volts. This pressure will be adopted until it becomes necessary to increase it, when it will be doubled and be delivered to the transmission lines at 22,000 volts. On its arrival in Buffalo it will be delivered to the step-down transformers of the Cataract Power & Conduit Co., which controls its distribution there, and will be transformed down to different pressures for distribution over the city. For a variety of purposes it will be used directly in induction motors, a number of which will probably be installed in grain elevators, etc. Several step-down transformers will also be placed in the station of the Buffalo General Electric Co., and from these, three-phase current, converted into direct current in rotary converters, will be utilized for lighting purposes and for small power units.

The Buffalo Railway Co. is also increasing its step-down transformer and rotary converter capacity in its Niagara St. power house up to 2,000 HP.

THE NEW PATENT OFFICE RULES, which go into effect on all cases filed after Jan. 1, 1898, provide that no invention submitted is patentable if it has been described in printed publications two or more years before the filing of the application. Heretofore if a foreign patent had been taken out before an American patent the term of the latter was limited to the expiration of the foreign patent. The new rules do not make this limitation, but if the period between the two patents is over seven months no American patent will be granted. A failure to prosecute an application for one year will be held to constitute an abandonment of it.

A STOP-COCK OF UNUSUAL SIZE, designed to resist the action of acid water, is illustrated in "The Iron Age" of Nov. 25. Two of such cocks were made by the Eynon-Evans Mfg. Co. of Philadelphia, for Slope No. 40 of the Lehigh Valley Coal Co., near Hazleton, Pa. The problem was to construct a 16-in. stop cock to withstand 100 lbs. pressure per sq. in., and to resist the action of water impregnated with sulphuric acid to such an extent that even bronze compositions yield in time to its action. The casing of the valve was made of cast iron, in two halves, which were lined with a special lead composition ½-in. thick. The plug, the yoke cover and the bottom cap were also made of cast iron and covered in like manner with the lead composition. The spindle, spindle nut, stuffing-box gland, and the worm gear used for operating the cock were of bronze. A lead lined by-pass valve was provided around the plug, for equalizing the pressure, and means were provided for lifting the plug slightly before rotating it so as to prevent its sticking fast. The total height of the stop-cock is 8 ft. 5 ins. and its total weight 11,989 lbs.

A COIN-IN-THE-SLOT LETTER REGISTERING machine has been placed in the New York city Post Office, and similar machines have been placed in the Bowling Green and the Equitable Building. It is called the Di Brazza Automatic Letter Register. It saves for the person who wishes to have a letter registered the time now wasted in standing in line in front of the registry window of the post office. In operation a dime is dropped in the slot and the letter in the mail box; a paper is exposed and the sender writes upon it his own name and address and the name and address on the envelope; he then pushes a button and the machine delivers to him a numbered, dated and signed receipt.

A NEW FORM OF TUYERE for blast furnaces, patented by Mr. A. P. Gaines, of the Tennessee Coal, Iron & R. R. Co., South Pittsburg, Tenn., and manufactured by Gustafson Bros., Sequachee, Tenn., is illustrated in "The Iron Age" of Nov. 25. The object of the tuyere is to effect a more perfect distribution of the blast over the area of the furnace than can be accomplished by the ordinary round-nosed tuyere. In the latter the air is projected directly towards the center of the furnace, leaving dead spaces between the sides of two adjoining air jets. In the new tuyere the shape of the opening is a peculiar oblong, longest in the horizontal direction, which is carried around the semi-cylindrical front of the tuyere, in such a manner that the blast is discharged sidewise as well as straight ahead, and thereby the whole horizontal plane of the furnace in front of the tuyeres receives an equal force of blast.

THE GOVERNMENT ARMOR PLANT, according to the estimates of the Naval Armor Plant Board, will cost $3,600,000 to establish. This would be for a plant capable of manufacturing plates up to 24 by 16 ft. and 18 ins. thick, with an estimated capacity of 6,000 tons per year. To prevent loss on the investment the board say it must be worked to its full capacity. This is enough armor for three battleships annually. Secretary Long is opposed to a government plant, and says that the prospective increase of the navy would not justify its erection, and its operation would be attended with loss to the government.

THE CEMENT WORKS of the Milwaukee Cement Co., near Milwaukee, Wis., were visited Nov. 23 by a party of about a dozen engineers from Chicago, by special invitation of the company. The works include a large mill with 20 kilns and a capacity of 2,500 barrels of finished cement per day, this being the greatest capacity of any one mill in the country. There is also a mill with 9 kilns and a capacity of about 1,000 barrels per day. At present only the small mill is running, producing about 500 barrels per day, as the summer is the busy time. The cement rock is obtained from an open quarry, the face of the rock being about 22 ft. high and 800 ft. wide. The kilns are mostly of the egg-shape pattern, but there is one of the Campbell kilns, with inclined iron grate bars forming the base. The rock is cracked and crushed in a series of stone mills, and the product is passed through separators invented by Mr. J. H. Berthelet, Superintendent of the works, the tailing from which are carried back to the mills. In the larger mill there are two Allis steam engines, one of 500 HP. for running the machinery, and one of 50 HP. for running the cable tramway to the quarry and the hoists. Large quantities of the Milwaukee cement have been used for the government locks at Sault Ste. Marie, and for concrete foundations for buildings and asphalt pavements, etc. After the visit to the works, the party was entertained at dinner at the Pfister Hotel, Milwaukee.

THE NEW YORK FIREBOAT "WILLIAM L. STRONG" was launched from the yard of John H. Dialogue & Son, Camden, N. J., on Nov. 27. This boat was designed by H. de B. Parsons, M. Am. Soc. M. E., and is built of steel, with the following dimensions: Length over all, 110 ft. and 102 ft. on water line; 20 ft. beam and 9 ft. draft. It contains two Scotch boilers, 10 ft. 1 in. diameter by 11 ft. long; Morrison furnaces, and a compound engine, 16 and 30-in. cylinders, 22-in. stroke. The steam pressure is 135 lbs. There are two duplex, crank and fly wheel fire pumps, with a capacity of 6,000 gallons per minute. With full complement on board, the displacement is 306.8 tons.

THE TIN-PLATE PRODUCTION OF PENNSYLVANIA is thus reported upon by the Chief of the Bureau of Industrial Statistics of Pennsylvania: In 1896 twelve concerns manufactured 158,306,490 lbs. of black plate, as compared with 104,757,360 lbs. in 1895. Of this amount 97,814,762 lbs. were tinned, as compared with 49,502,000 lbs. tinned in 1895. The value of the entire product, black and tinned, in 1896, was $4,633,161; in 1895 the product was valued at $3,252,924. The average value of the tinned plate is $64.56 per net ton, and that of the black plate was $48.94. The industry employs 3,144 people, with an average of 254 days employed in 1896, and average yearly earnings of $456.55. The average daily pay is $1.80, as compared with $1.87 in 1895.